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The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Trading Nationally

A political slogan, "Learn to Think Imperially," impressed us very deeply at a time when a modicum of respect for slogans was still with us. A piece of advice which modern-minded people would designate a slogan, and which is peculiarly applicable to the foundry industry, is "Learn to Trade Nationally." In pre-war days, the foundry industry, with a few exceptions, was conducted on a regional basis, but with each cyclic slump, the more enterprising firms endeavoured to keep the staff fully employed by seeking orders on a national basis. Unfortunately, this was often accompanied by price-cutting, but as the notion of national business grew, more economical systems of manufacture became possible, and the lower prices quoted were still profitable. Moreover, the orders placed on the national rather than the regional market commanded a higher price than those quoted regionally, due to the fact that the specifications were more rigid and *per se* excluded those concerns not possessing a well-devised scheme of technical control. There is, and always will be, a large tonnage of orders for castings placed locally, because of friendships, convenience and experience. An important factor which tends to concentrate orders in the most efficiently conducted foundries is the institution of standards. Thus, heavy pipe founding has now been concentrated in the hands of less than half-a-dozen concerns. A second factor has been the repercussion of quantity production processes on the foundry industry. This, of course, is related to the former consideration, as it involves the production of large quantities of castings from one standard pattern. A number of foundries realising this tendency in industry equipped their shops specially to deal with such conditions. The acquisition of such plant brought with it a reputation for quality, which has resulted in oft-repeated statements in widely-separated areas, that this or that city or district cannot make a high-grade easily-machinable sound casting. Thus, one can see along the great main roads of England lorries conveying castings from one foundry area to another. The lesson for the average foundryman is clear. He must determine whether his line of manufactures can be or is likely to be standardised; whether a demand exists elsewhere than his own immediate district for the castings he makes; and why his business is purely of a local character. If it be decided that the trade he is to undertake is always to be local, then he should take steps to ensure remunerative prices for his work through his local foundry employers' association. When we advocate "Learn to Trade Nationally," we define the word "trade" as "a transaction which involves the sale of goods on a profit-yielding basis."

The Enamelled House

We are all familiar with the great extension of the vitreous-enamelling process in domestic ware, such as stoves, grates and cookers, and equally with the post-war attempts to develop the use of cast iron and steel for housing construction. If some news from New York is to be relied upon, we are not far from the enamelled house. The enamel is said by the architects to be as hard and durable as porcelain, and is quickly cleaned by spraying a hose upon it. In the States it is said that half the cost of an ordinary house goes in wages during building, and with the enamelled steel house this is reduced to one-third. The material used is thin sheet, insulated on the inside from external temperature changes by a suitable packing. The enamel may give scope to the bad taste which unfortunately characterises much recent building. Another American idea for housing, which seems rather far-fetched, is to have a house built on the lines of a vacuum flask, built of hollow bricks from which the air has been extracted. Doubtless an English preference for fresh air, even if cold, would kill the idea in this country. However, the glass-walled house is visualised as a possibility in many quarters, as is the synthetic-resin type of structure. So one can foresee a house in which the ground floor is a hangar for a small aeroplane, with living rooms above, and a flat roof for garden, sunbathing and sport. Doors will open by the mere action of approaching them, and a wireless and television set will put the owner into visual and aural communication with any part of the world by turning a switch. Some of these ideas may sound fantastic, but we mention them to show the ferment of ideas going on against which nothing in the established order of things is proof. The moral is that nothing but continuous thought, experiment and advance will serve to keep the foundry industry in its proper place, and we believe that if this is done it will advance rather than regress. In a world with an expanding standard of living our products should find an increasing place, even if they change their character.

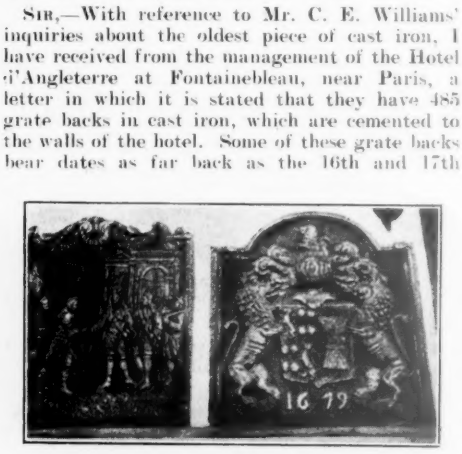
Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Oldest Grey-Iron Casting

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to Mr. C. E. Williams' inquiries about the oldest piece of cast iron, I have received from the management of the Hotel d'Angleterre at Fontainebleau, near Paris, a letter in which it is stated that they have 485 grate backs in cast iron, which are cemented to the walls of the hotel. Some of these grate backs bear dates as far back as the 16th and 17th



17TH CENTURY GRATE BACKS FROM THE HOTEL D'ANGLETERRE, FONTAINEBLEAU.

centuries. The subjects represented are usually coats of arms or allegorical designs, and a number of the grates came from some of the royal châteaux. Some of these castings date from the so-called Chinese period under the reign of Louis XV, when many pieces of furniture and ornaments followed more or less Chinese designs.—Yours, etc.,

V. DELPORT.

Caxton House (East),
Westminster, London, S.W.1.
January 28, 1935.

Sand Blasting

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Your issue of January 17 contains an article on "Sand Blasting," which had been read at a meeting of The Institute of Vitreous Enamellers in London. Having had the pleasure of meeting the author in the past, and knowing him as a virile personality in constant touch with sand blasting, I feel reluctant to enter into controversy. Nevertheless, I contest one or two statements contained in his article, because they are misleading, and one encounters too many fallacious ideas amongst users and potential users when discussing sand-blast plants as it is!

Firstly, then, Mr. Hill claims that twice as much work is accomplished using air at 50 lbs. as will be done with air at 24-lb. pressure, and sand blasting with a 60-lb. pressure will double the work done at 30 lbs. This is incorrect, because the extent of work done depends on the bore rather than the pressure; 60 lbs. per sq. in. will blast twice as hard, but not twice as much as 30 lbs. In short, for economic sand blasting, the minimum pressure calculated to clean the components should be used, for there is no point in causing an impact more violent than that calculated to carry away the foreign matter. The exception, of course, is vitreous enamelling, where it is necessary to cut a key on the surface, but even then the pressure should not exceed that necessary to effect its purpose.

Mr. Hill claims to have investigated the relative popularity of types of plant. He dismisses the barrel plant in a few words by saying that the results derived from them are too inconsistent to warrant confidence. Surely that depends on the machine, for I have seen castings cleaned in the continuous-barrel plant built at Manchester that would flatly contradict that statement. The castings in question were automatically fed, blasted, turned over and blasted on the reverse side and then delivered, spick and span, through a shute!

Still dealing with types of plant, we read that the room plant is the most popular, but is closely followed and soon to be superseded by the rotary table. Where is the authority for that? Mere logic, even though devoid of technical skill, precludes the possibility of rotary tables superseding room plants. Even on a well-packed table the ratio of wasted energy must be appalling, and hygienic arguments lack conviction, because a man in a satisfactory sand-blast helmet is thoroughly protected, whereas the operator adjacent to a rotary table cannot hope entirely to escape from the menace of dust.—Yours, etc.,

C. J. NURCOMBE (Managing Director,
H. G. Sommerfield, Limited).

January 23, 1935.

Catalogue Received

Safety Clothing. We have received from Messrs. S. Pulzer & Son, Limited, 45, Hatton Garden, London, E.C.1, a very interesting folder, somewhat reminiscent of the sales catalogues issued by big London Stores. This feature is due to the fact that suits, overcoats, gloves and boots are illustrated in the approved style, but they all relate to asbestos garments. Moreover, there is a paragraph reading that the clothing is available in three weights of cloth—heavy, medium and light-weight cloth, whilst those unable to wear stock size can have their clothes made to measure. The designs shown have been extremely intelligently thought out, so as to afford a maximum of protection from heat and fire risk, whilst according freedom of movement and efficient ventilation. Protection from acid is also provided for.

Accompanying this folder is a leaflet describing and illustrating two types of face screens. The first is made from either a treated cellulose material or mica, and the second is made from the finest of fine-mesh fabric held on a flexible-steel band. Light is eliminated to only a very inappreciable extent, whilst full protection is afforded against getting particles in the eyes. These face screens seem well capable of replacing goggles in a variety of places about a foundry.

MR. JOHN CRAIG, C.B.E., chairman and managing director of Colvilles, Limited, in proposing the toast of the Corporation of Glasgow at the annual dinner of the Iron, Steel and Ironmongery Benevolent Association of Scotland, spoke of the benefits which the corporation in the past had conferred on the city. He was afraid, however, he would have to speak differently of the present and of the future. There was a possibility that the communal services were going to include the supply of bread, and, as the society developed, he supposed that the corporation would produce cigarettes for the citizens.

Random Shots

"Marksman" last week played a very popular card game in which the cards represented letters of the alphabet. The game is a strenuous one, demanding a crossword-puzzle intellect and a good grounding in the spelling of the more unusual words in the English language. Unless all words are checked by a dictionary, there is also good scope for ingenious cheating. The better players, I believe, bar Australian birds and African rivers. The game raised in "Marksman's" mind (such as it is) some problems anent (good word) the spelling of semi-technical terms.

* * *

Take, for instance, the omission of the doubled consonant in such words as "riveted," "focused," "pivoted" and "jacketed." The Institution of Mechanical Engineers in their booklet, "Information Concerning the Preparation of Papers," insist on the single consonant. Quite right, you may say. No one, you may think, could cavil at that. But let us take a hypothetical case. Suppose that "Marksman" were given Lord Castlerosse's job. Suppose he had to describe the scene on Gold Cup day at Ascot. He would probably straightaway grip his readers with a graphic description of "the brilliant scene, the jewelled gowns, the ruby faces of the top-hatted and spatted owners. . . ." You see? "Top-hatted and spatted." The double consonant. Apply the single-consonant rule to that passage of English literature and you have "top-hated and spated," which is just silly. The whole thing goes to prove that where spelling is concerned one should not be too exacting.

* * *

People with inelastic minds demand that compound words, used adjectivally, must be either hyphenated or printed as a single word (*e.g.*, "*collecting-belt* conveyor" or "*axlebox* manufacturer). So far, so good, but take another example, a favourite meal of "Marksman's." Must it be either "Champagne-and-fish-and-chip supper" or "Champagneandfishandchip supper"? The first specimen is ugly, containing four hyphens, and the second difficult to read. The fact is that we must use our discretion in these matters. Here a hyphen, and there a double consonant. After all, as I told my opponents in this alphabetical card game, English is a living language. New words come in, archaic words go out. Our ancestors considered themselves correct when they wrote about "Ye olde shoppes"; the best people spell those words differently to-day, but to-morrow—who knows? Even so, my pigheaded, unimaginative opponents insisted that "iron" could not be spelt with two "r's." I lost the game.

* * *

A correspondent informs "Marksman" that in the new mass-production standardised baths now being manufactured for houses costing £500 and over, the familiar "Hot" and "Cold" on the taps have been replaced by red and black bakelite shields. Now that the heating engineer understands his business far better than his father did, it seems a pity that the legend "Hot" should disappear from the bath tap at the very time when it really means what it says. We might have respected the old-fashioned plumber more if he had had "Luke Warm" printed on the tap, for how often has that "Hot" been nothing more than a mockery of truthful designation?

MARKSMAN.

Gifts Received

We acknowledge with thanks the gift of two diaries, containing valuable technical data and interesting photographs illustrating the firm's works and activities, from the Clay Cross Company, Limited, near Chesterfield, and also the gift of refills for a desk blotter from Messrs. Spencer & Halstead, Ossett, Yorks.

Deoxidation and Degasification of Yellow Brass*

By L. A. WARD†, Waterbury, Conn., U.S.A.

[Abridged.]

This Paper outlines briefly the salient facts known and analyses them to find how best to deoxidise and degasify yellow brass. This Paper is divided into two parts, the first dealing with deoxidation and the second with degasification. By yellow brass is meant, for the purposes of this Paper, a brass of not more than 75 per cent. copper, consisting essentially of copper and zinc, but with the permissible addition of lead, tin, and small amounts of other alloying metals.

PART I—DEOXIDATION

What oxides can be present in yellow brass? It is necessary to consider the oxides of all the elements present and see whether or not they can be present. If they can be present, it is then necessary to consider whether this is probable.

Copper.—The first to be considered is copper oxide or, more properly, cuprous oxide. If one makes a brass using virgin metal, in all probability the copper will be melted first and then the zinc will be added. In this primary melting of the copper, some cuprous oxide undoubtedly will exist. The question then is whether or not this would be reduced on the addition of zinc. Zinc is a very powerful reducing agent and there is no doubt that it can, and does, reduce any cuprous oxide that may be present.

If, then, there is no possibility of having cuprous oxide present, what of the other oxides? Zinc being the only other major constituent present, its oxide should be considered next.

Zinc.—Zinc is readily oxidised under ordinary melting conditions, but zinc oxide does not dissolve readily in the brass, and therefore, if it is present, most of it is simply mechanically entrapped. That such is the case has been shown by such workers as O. W. Ellis, who reported on the amount of zinc oxide present due to varying melting conditions and analyses. Lumps of this oxide often become disengaged and fall into the melt, where a portion of them are broken up into fine particles. It has been shown that these particles are so fine that they cannot be separated from the melt by gravity and hence cannot be removed by skimming.

Ellis also called attention to the practice of many foundries using barrel-type furnaces, of filling the furnace full of scrap and sometimes even heaping it up outside the door. Wholesale oxidation of the brass certainly takes place under these conditions, no matter how reducing the flame may be or how well the molten metal is kept covered by charcoal or a slag. Very probably, brass melted under such conditions would contain much zinc oxide, and therefore certainly would not be suitable for producing high-grade sand castings.

Tin.—Tin is one of the minor constituents that may be present. Tin is added to brass either in the scrap used or as the metal itself. If it is added in the scrap, zinc probably will be present so the tin will not be oxidised. When added as the metal, tin usually is added after the zinc, and therefore will not tend to oxidise. Any tin oxide in the melt will be present due to oxide already on the tin before adding it to the brass, and the amount present will be negligible.

Lead.—Lead is another of the minor constituents that is frequently present. If scrap containing lead is melted, there is a possibility that some of the lead would become oxidised during the early stages of the melting. This oxide might be retained in the melt as physically entrapped particles much as zinc oxide is. It is the opinion of the writer that the amount present will be negligible.

Influence of Oxides of Deoxidisers

Oxides of deoxidising agents used may be present. When using aluminium, silicon, or manganese, the oxides certainly are retained, and in some cases seriously affect the quality of the castings.

Aluminium.—It is a well-recognised fact that brass castings in which aluminium is used as a deoxidiser are unsound, and fractures of these castings often show quite large particles of aluminium oxide present.

Silicon.—Silicon also is oxidised and the oxide is retained in the casting as finely-divided silicon dioxide. The oxides of both aluminium and silicon, if present in the casting, will make the brass difficult to machine and necessitate frequent grinding of tools.

Manganese.—Manganese is often used as a brass deoxidiser and in many cases proves useful. At times, however, the manganese is oxidised to manganese dioxide and is retained in such a fine state of subdivision that it cannot be removed, and on solidification of the casting is precipitated in the grain boundaries. Such was the case in a recent casting series of 75 per cent. copper, 4 per cent. lead brasses deoxidised with various agents. In the case of the manganese deoxidised castings poured at 980 deg. C., the tensile strength was 12 tons per sq. in. These castings showed a clean dense structure on fracturing. When the pouring temperature was raised above 1,093 deg. C., the tensile strength dropped to 6.2 tons per sq. in. and a fracture showed very large radial crystals completely surrounded by a thin film of manganese dioxide, dark brown in colour.

Phosphorus, Lithium, Calcium, etc.—This leaves, as suitable deoxidisers of brass, only phosphorus, lithium, calcium, etc. Phosphorus, when oxidised, passes out of the metal as a gas. Little or no work has been done on the use of lithium or calcium as deoxidisers of brass. They are used extensively for copper with excellent results, and if it is possible to judge by these results, they should prove to be some of the most satisfactory deoxidisers available for brass.

How, then, shall brass be deoxidised? In the first place, deoxidisation of yellow brass, as normally considered, is unnecessary. With the amount of zinc that is present, it is impossible to have any copper oxide present and none of the common deoxidising agents would reduce the oxides of zinc, lead and tin that would be present. This being true, what is the actual function of the common deoxidisers? For the most part, they are what might be termed fluidisers. They may also, by changing the equilibrium, function as degasifiers, but that use does not rightfully belong in this section of this Paper.

Aluminium, although harmful in many ways, often is useful in the brass foundry as an aid in getting sharp impressions in castings where there are no pressure requirements. When used this way, great care must be taken that, through carelessness, other mixtures are not contaminated. As to its effects on the casting other than those cited, it increases the grain size and makes it possible to use lower pouring temperatures due to the increase in fluidity.

Phosphorus Increases Fluidity

Phosphorus, like aluminium, also increases the fluidity of the molten brass and the metal takes a much sharper impression in the mould. Unlike the aluminium, it does not show a tendency to increase the grain size of the casting when the temperature is held the same. Silicon has the same property of rendering the metal more fluid when used as a deoxidiser, and like aluminium, tends to increase the grain size. Physical properties at the various casting temperatures show the same tendency as with phosphorus; namely, that at a low casting temperature the presence of silicon is beneficial, while at the higher temperatures it is detrimental, if anything.

Control of Melting Conditions

One method of deoxidation that is most important is the proper control of melting conditions and the protection of the metal during melting by slags or charcoal. Sound castings with a minimum of oxide inclusions can be made using any of the commercial melting furnaces if controlled properly. The atmosphere should be kept neutral or slightly reducing, and the charge should be added only as fast as it can be melted with the proper protection.

As to the benefits derived from the use of slags or charcoal, there are ardent advocates of both, and good clean metal may be produced with either. When large amounts of scrap, particularly dirty scrap, are being melted, a slag cover usually gives superior results, since it does remove a large proportion of the foreign material by dissolving it, and therefore aids the caster to skim the pot clean.

(To be concluded.)

* Paper read before the American Foundrymen's Association at the International Foundry Congress at Philadelphia.

† Metallurgist, Chase Brass & Copper Company.

Standard Baths

The standardisation and mass production of housing equipment was carried a step further last week when the British and foreign bath manufacturers announced to the trade the first standardised rectangular baths for houses of £500 and upwards. Until recently there were 998 different patterns and sizes of baths. The clean, modern lines of the new bath, the low rim, the way the rim fits into the wall, and the choice of panelling are intended to make a strong appeal to the trade and public. Practical advantages to the householder, it is stated, include avoidance of splashing, ease of cleaning, and economy in floor and wall covering. The words "Hot" and "Cold" will no longer appear in print on the taps, which are distinguished in colour. The new standard baths are being made in London, Manchester, Stockport, Leeds, Coalbrookdale (Shropshire), Bilston (Staffordshire), Glasgow, Falkirk and Barrhead.

Production of Electricity

The annual report of the Electricity Commissioners for the year ended March 31, 1934, points out that the total output (units generated) by authorised undertakers in 1933-34 amounted to 14,175,000,000 units, an increase of as much as 1,669,000,000 units, or 13.3 per cent., on the output in the previous year, and three-quarters of that increase took place during the last six months of 1933-34. The increase was the largest recorded in any year since the commencement of the issue of official statistics by the Commissioners in 1920-21. The industry has been connecting new consumers at the rate of between 500,000 and 600,000 per annum, and its output (units generated) had grown from 10,526,000,000 units in 1929-30 to 14,175,000,000 units in 1933-34, an increase of 3,649,000,000 units in four years, representing an average increase of 910,000,000 units per annum. The aggregate capacity of the generating plant for new stations and extensions of existing stations sanctioned by the commissioners during the year 1933-34 amounted to 114,096 kw., as compared with 66,774 kw. in the preceding year and an annual average of just over 480,000 kw. during the past 13 years. Regarding production costs, fuel is an important factor. The amount of coal and coke consumed in the year 1933 in the stations of authorised undertakers amounted to upwards of 9,595,000 tons. Copies of the Report may be obtained from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. (Price 3s. net.)

Short Paper Competition

MIDDLESBROUGH BRANCH MEETING

The experiment of inviting members to contribute ten-minute Papers on foundry problems proved highly successful at the last meeting of the Middlesbrough Branch of the Institute of British Foundrymen. The first prize-winner was Mr. J. C. Charlton, of Hartlepool, with Mr. W. Peake, of Middlesbrough, second. The following are some of the Papers:—

Die-Casting

BY H. FOSTER.

This Paper is an attempt to stimulate interest in the lighter side of the foundry industry.

There are two methods used: Pressure and gravity. The materials used in the manufacture of the dies must have very careful attention, as heat-resisting properties and the elimination of expansion and contraction are important. Nickel-chrome steel and heat-resisting cast irons are used.

The dies have to be exceptionally well made, and this requires technical skill of a very high order, as the designs must be arranged in such a manner that the castings can be easily ejected when cast; joint lines and loose pieces have to be clearly understood, and any undercuts that may retard any contraction of the metal must be arranged for. Other points to be considered are runners and risers, and venting. Moreover, the dies must be constructed so that they fit perfectly together and must be arranged so that no mistake can be made on assembling.

Many advantages are claimed for die castings, chief amongst which are the following:—(1) Rapid production of parts; (2) uniformity of the product; (3) accuracy of the casting; (4) considerable economy owing to saving on machinery and in the weight of metal required for the article; (5) superior finish; (6) improvement in the physical properties of the metal; and (7) reduction in the percentage of defective castings in machine shops.

It is obvious that the dies constitute a large portion of the work involved in producing castings; indeed, much thought and experience has to be brought to bear upon a proposition before the die is even started upon.

The process is continuous and more rapid, the dies will produce thousands of castings without renewal, and they can be operated to a great extent by unskilled labour. There is no doubt that die castings have revolutionised the non-ferrous foundry trade where a large number of castings are required. In fact any mechanical part, unless too large or with the coring too intricate, can be produced in dies from castings weighing, say, ½ oz. up to 30 lbs., if adequate quantities, say 500 and upwards, are required.

The operation of the dies must be fairly rapid, otherwise the temperature of the dies will rapidly drop, as it is imperative that the dies must be kept up to a fairly high temperature. A point may be raised regarding price; due to the aluminium alloy being so light it compares favourably with brass or gun-metal, as approximately three castings can be produced for one in the case of copper alloys.

Generally speaking the standard alloys used are: (1) Aluminium-copper alloys; (2) aluminium-silicon alloys; (3) zinc-aluminium alloys, and (4) "Y"-alloy containing copper, nickel, magnesium and aluminium.

Quite good physical conditions can be obtained, as, for instance, tensile, 10 to 14 tons; elongation, 4 per cent. on 2 in., and Brinell hardness, 61 to 90.

The melting of the metal is usually done in special heat-resisting cast-iron pots, whereby a continuous supply of metal can be dealt with. An important fact is the temperature at which the metal is cast, which should be under pyrometer control.

Charging to Tapping of a 30-cwt. Electro-Metals Electric Furnace

BY J. SAUNDERS.

In starting the furnace for melting and refining, steel scrap, such as old bolts, plate cuttings, turnings, etc., are charged into the furnace, and the electrodes are lowered sufficiently to establish an electric circuit, the current passing between the electrodes and the charges. At first, before the scrap is melted, the electrodes are generally in contact with it, and numerous small arcs and high resistance contacts are formed between the pieces of scrap, which largely absorb the energy of the current. The resistance of the charge varies greatly during this period, violent fluctuations of the current taking place owing to the continual change in contacts and disruption of circuits, but gradually, as the scrap melts and an arc is established between each of the electrodes and the molten bath, the greater part of the energy is absorbed by these arcs. When the bath is melted, the electrodes are kept just above the surface of the slag. Lime and spar are added from time to time, and when the bath of scrap is completely melted and the slag in condition, the current is switched off.

The furnace is then tilted and the slag poured off. To remove the slag completely, the surface of the steel is skimmed with a wooden rabble, the slag being raked off the bath through the door. It is necessary to remove all the slag, as the phosphorus from the steel is now combined with the lime, but if any phosphoric slag remains in the furnace, the phosphorus to a large extent returns into the steel under the reducing conditions of the final process. When the slag is removed, anthracite coal and ferro-silicon are added on top of naked steel to make any desired quality of steel. Further additions of lime and fluorspar are then made to form a finishing slag, to remove the last traces of impurity. A mixture of fluorspar, lime ferro-silicon and anthracite is added at intervals, and the required amount of ferro-manganese is added to the bath 7 min. prior to tapping. The bath is sampled in the usual way with a spoon ladle. A little aluminium is added into the ladle on tapping.

Some Practical Hints on Green Sand Moulding in Cast Iron

BY W. WADDELL.

Moulding with green sand is a branch of founding which requires the utmost skill of the moulder. A good green sand moulder is a valuable asset, especially one who will adapt himself to the circumstances required to be adopted with any quality of moulding sand. Often different results are obtained by moulders performing what would appear to be identical operations—a difference which acts for or against the casting.

The green sand used often receives much of the burnt core sand when the castings are removed from the floor or boxes, and it is advisable therefore to use a ¼-in riddle to remove any lumps; also less water is necessary to bring to a working condition, the damp clots being broken up and distributed throughout the mass. This prevents wet clots from coming in contact with the face of the mould.

The quality of the facing sand is the most important to be considered; the mixing must be under strict supervision for uniformity of bond and dampness—one must strike a happy medium. If in doubt about the mould being too wet on face, it should be skin dried with a piece of waste dipped in paraffin. This method has been found from experience to give a beautiful blue skin finish on the casting.

Scabbing is often caused by excessive tool sleeking, absence of or incorrect venting, hard or soft ramming, bad design of runner and riser gates, blacking cores when too hot, and allowing cores to stand too long in mould before casting which causes moisture to collect. Always use pure tinned chaplets. Strict attention must be paid to gates and runners; bad gating involves bad castings.

The basin should be large enough to hold more than sufficient metal to keep the runners full, and also a good head during pouring. The best facing for green sand is pure Ceylon plumbago, which prevents the metal from eating its way into the mould, and at the same time forms a skin or face on the casting which will cause it to strip easily from the mould, and so reduce the cost of fettling to a minimum.

Where loose strips on patterns have to be drawn in, or if old iron castings are used for patterns, a good notion is to rub over with paraffin, then dust over with parting powder; this will ensure a clean draw and will also act as a good means for venting the mould. The same can be used successfully on gratings when round holes are to be cored out.

The metal to be used for casting should be controlled by the foreman, the manager, and the chemist, as in 99 cases out of 100 the moulder has no knowledge or control of the iron to be used. And in conclusion, the patternmaker and the moulder—let them get together as two heads are better than one.

The Testing of Foundry Sands for Permeability

By J. GOULD.

Many elaborate sand-testing machines of different design have been tried, and much valuable information has been gained from the use of these; yet amongst all the ideas until now, there have been few, if any, which could be used on the actual work done by the moulder. They have had to depend mainly on separate rams. Does this not suggest that the human element has not been considered? Watch a few moulders working and examine the rammers used; one man has a rammer worn at the point to such an extent that side ramming seems to be its main function; another has a new flat-ended tool which simply pushes the sand downward until the end is worn to a different shape. Either of these men may ram a thick or thin filling of sand each time. If the moulder is one of those people whose back, and not whose brain, is the leading factor, he may cut the mould to pieces, in the sense that one part will be quite hard and another part, more especially near the bars of a top box, will be quite soft. In a mould of this sort, the permeability may be affected by the near neighbourhood of soft spots, which allow the vent from hard places partially to escape. From a mould of this sort one might get a definitely sound casting; true, it might not be quite so good looking to the practised eye as the casting produced by that moulder who uses his rammer correctly, turning the rammer round in his hands to tuck the sand up to the pattern in a manner which shows care, in regard to the shape of the job. The permeability at different parts of the mould is largely affected by the moulder's skill with his rammer.

The author would like to suggest that an apparatus designed on different lines would possibly be of use to test the actual moulds. Obviously, the place of lowest pressure when a mould is cast is the top face of the casting. The pressure here is fairly constant at about

(*Concluded on page* 102.)

A Discussion on Sandblasting

RELATIVE MERITS OF SHOT AND SAND

At a meeting of The Institute of Vitreous Enamellers held in the Council Chamber at British Industries House, Marble Arch, London, W.1, Mr. B. B. Kent in the chair, MR. KENNETH HILL read a Paper on "Sandblasting." This was printed in our issue of January 17. It was followed by an interesting discussion which is summarised below.

DISCUSSION

The CHAIRMAN (Mr. B. B. Kent), commenting on the author's statement that moisture must be removed from compressed air before delivery to the sandblast to prevent dampening of the abrasive, asked which was the best method of removing that moisture completely.

Removing Moisture from Compressed Air

MR. HILL replied that there were several ways of removing moisture from compressed air, but he did not think there were any that could be considered as being definitely reliable. One method was to burn a small Bunsen or other gas flame just beneath the air inlet pipe immediately before the point at which the pipe entered the bottom hopper. Sometimes, however, the compressors ran hot and the air was already hot before it entered the hopper, and in such a case the gas-flame method was ineffective. Another method was to place an expansion chamber on the pipeline, near the hopper. That chamber contained baffle plates; the air passing through the pipe from the air tank impinged upon the plates so that any moisture in it condensed and dropped to the bottom. A tap was provided at the bottom of the expansion chamber in order to release that moisture. At the moment he was of the opinion that the removal of moisture from compressed air was best done by that means, as it was more positive than the other method. Even if one provided a Bunsen flame under the air inlet pipe, the moisture in the air had to go somewhere; it would not disappear entirely. He knew of several other methods, but had not mentioned them because they were not satisfactory.

The Use of After-Coolers

MR. HARTLEY suggested that the most efficient system for removing moisture from compressed air was that of using an after-cooler. This might be regarded as expensive from the point of view of the quantity of running water that had to be used, but he regarded it definitely as being essential. If one provided sufficient cooling surface in it and could secure a sufficient flow of water through it, the air temperature could be reduced to about 10 to 20 deg. Fah. above the ordinary temperature of the cooling water. The best place at which to fit the after-cooler was between the compressor and the air receiver. It was also advisable to instal a receiver of large capacity, and the compressor makers generally advised this. Manufacturers could definitely guarantee to deliver compressed air at 60 lbs. pressure at a temperature of about 70 deg. Fah., with inlet water temperature 50 deg. Fah., by using an after-cooler; naturally, that air did not contain very much moisture, because its temperature was near atmospheric temperature.

With regard to the author's suggestion to provide for alteration of the volume of air from the compressor by fitting a compressor of greater capacity than was required for immediate needs, and reducing the speed as the demand for air was reduced, Mr. Hartley was of opinion that that was an expensive means of controlling volume, particularly as the modern trend was to use a.c. motors, and to provide these variable-speed motors meant very expensive control gear. He considered it better to use two compressors, probably multi-cylinder, so that one could vary the output by cutting out one or other of the compressors, and still further reduce the output by cutting out the respective cylinders on these multi-cylinder machines.

Cost of Cooling

MR. J. T. GRAY referred to a plant in which a 600 cub. ft. compressor was used normally during the day and another 300 cub. ft. compressor was installed to meet peak loads and to run during the night; in that instance an after-cooler was used. He pointed out that air was very often heated by the friction of compression and was then cooled down, and condensation occurred at that point. But, even so, in the plant referred to, a little moisture leaked through to the actual rotary table and the cabinets, which were situated at a considerable distance from the compressor house, and the use of Bunsen burners under the inlet pipes was reverted to. The amount of moisture leaking through to that point had been very small, of course, but if the after-cooler had not been installed the trouble due to moisture would have been almost sufficient to render the plant unworkable. The water consumption of such coolers, however, was a matter to be borne in mind; at the plant referred to the after-cooler was using about 50 galls. per min. Thus, unless a works were situated near a canal, this method of cooling was very expensive.

Installation Difficulties

MR. HILL pointed out that the two methods he had mentioned for extracting moisture from compressed air—the Bunsen-flame method and the expansion-chamber method—were non-mechanical; there were no working parts and they required no maintenance. But he asked if Mr. Hartley considered that in the average sandblast plant installed in this country—and he regretted to say that often the compressor house was at one end of the works and the sandblast plant at the other, so that a long pipeline had to be used—an after-cooler placed between the compressor and the air receiver would be effective in disposing of moisture. How could that dispose of the moisture formed between the air receiver and the hopper of the sandblast plant? It seemed that it would still be necessary to apply some other method, such as a Bunsen flame or an expansion chamber.

MR. HARTLEY replied that that depended on how far one could reduce the temperature of the air coming in from the air receiver. It was possible to reduce it to within about 10 deg. Fah. of atmospheric temperature, if the after-cooler were provided with sufficient cooling surface; and that was the main point, to get the air temperature down to the temperature of the suction side, because then one was bound to get rid of practically all the moisture.

Oil plus Water Extraction!

MR. A. B. KENT pointed out that maintenance staff were apt to fill oil into the compressors to just a little above the proper level, and it was found that the after-cooler removed oil from the air coming from the compressors, but not the water.

Commenting on the references made to the length of pipeline between the compressor house and the sandblast plant, he said that in one case at his works a rotary table was situated at about 10 ft. from the compressor house, and at first it was found that, even when an after-cooler was used and the containers were kept quite cool, the table would have to be shut down after about a couple of hours. The fitting of a Bufix separator, however, had cured all the trouble.

MR. B. B. KENT said that surely the water used to cool the compressors could be first passed through the after-cooler, so that the after-cooler should not involve the use of a great deal of extra water.

MR. HARTLEY said the trouble was that usually the compressor-cooling water was circulated from the compressor back to the tank.

MR. KENT did not consider that that was possible in a big installation; a compressor delivering over 300 cub. ft. of air per min. would need a big tank!

MR. HARTLEY said it was general practice to do that, in view of the cost of water. Of course, one could use water from the compressor for the after-cooler.

MR. KENT added that at his works a well had been sunk; the water was pumped from there to the roof, was run over a cooling tower, and was used again.

Abrasives and Surface Dust

MR. P. C. MUZZELL, commenting on the wear of flint abrasive, as the result of which particles were left on the surface of the treated metal, and presumably were enclosed by the enamel in the subsequent enamelling process, asked whether metallic shot also wore, and, if so, whether it had any effect upon the enamelling, or whether any particles adhering to the sheet were removed before enamelling.

MR. HILL replied that flint did not wear, but fractured. It had cleavage lines, and its minute crystals were held together by a common bond. Impact, however, disintegrated the crystals, and the process of fracturing continued until the flint was reduced to a powder having no abrasive properties at all. In almost all cases this was blown on to the casting, and he understood that it acted as a flux and assisted the fluxing action. There was no breaking-up or powdering of metallic abrasives, however, but a gradual wear, and the small particles of metal worn off were taken away through the dust-exhaust system.

Effect of Surface Dust

MR. J. T. GRAY recalled that, when steel shot was first introduced—he believed it was introduced in America—it had become more or less a sales slogan that it had a longer life than flint grit; and the flint grit firms had retaliated by saying that, if metallic shot were used for blasting, small particles of the shot would be retained on the castings, and in the subsequent enamelling process they would cause black specks or "boiling-up." Then a mixture containing 50 per cent. of each was used, and it was held that the steel shot would do the pounding and the flint grit would have a scrubbing or cleaning action; and, further, that any flint grit retained on the castings would not be detrimental to the enamelling, because it was of the same basic material as the enamel. He did not know how the idea had arisen that a film of silica dust acted as a flux, and he believed it was absolutely incorrect. It could not act as a flux, because it was part and parcel of the basic material of the enamel.

In sheet-steel enamelling, a borax bath had been introduced, and it was said that that left a film of borax on the sheet, which film would act as a flux. One could understand that, because borax was an enamel flux, but flint was certainly not.

MR. HILL said he had stated that "he was given to understand" that the flint material acted as a flux; he had not stated definitely that it did so. But, with regard to the point that particles worn from steel shot impinged on the castings and caused black spots, and so on, in the enamelling, he had covered that by advising that in all types of sand-blasting plants for the cleaning of castings for vitreous enamelling one should use an abrasive separator and cleaner, because failure to free the metallic abrasive of graphitic carbon would result in poor enamelling.

MR. GRAY said he had mentioned the point about the effect of small particles of shot on the

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casting merely as a point that had been made some time ago; but the fact that about 80 per cent. of the plants in Great Britain were using steel grit seemed to prove that the theory about metallic substances being left on the castings was wrong.

MR. THOMAS confirmed Mr. Gray's contention that flint could not act as a flux, because the temperature of fusion of pure silica was in the neighbourhood of 2,000 deg. C., and that temperature would never be attained in any enamelling muffle.

Pore Closing or Fissuring

MR. HEWISON asked whether the effect of angular steel shot impinging on a casting was to close the pores, thereby enclosing some of the impurities in the casting, which impurities would reveal themselves later during the enamel-fusing operation.

MR. HILL replied that angular steel shot had the opposite effect. The photo-micrographs of any casting sandblasted with metallic abrasives revealed small indentations, which meant that the surface was opened up by minute fractures, but only if one were using the proper grade of shot. On the other hand, one could use a size of steel shot, or of flint, which would definitely close up the holes in a casting if it were soft enough.

MR. J. H. COUPE said he was given to understand—as he had stated in his recent Paper*—that two very large firms in this country had changed over from flint grit to angular steel shot as an abrasive, but that they had recently been compelled to revert to the use of flint grit, as it was found that castings treated with angular steel shot were not satisfactory for producing an acid-resisting vitreous-enamelled article. His own experience, which covered both types of abrasive, was that flint grit definitely had a more searching effect than angular steel shot; he still maintained that angular steel shot had more of a battering than a cleansing effect on the surface of the metal.

MR. HEWISON, who had also had experience of the use of both types of abrasive, for his company had had two sandblasting departments, one of which was using steel shot and the other flint grit, said that the results obtained with steel shot were not so good as with ordinary sand. He could not state definitely the reason for that result, but it would appear, from Mr. Coupe's remarks, that there was something in the art of using it.

Design of Plant and Abrasive Used

MR. J. T. GRAY pointed out that the plant or equipment installed at a works had a great bearing on the choice of abrasive. He mentioned one case in which the result of changing from flint grit to steel shot had been complete failure, and said that if those responsible for the plant had sought the advice of a sandblast-apparatus expert he would have advised them in the first place not to make the change, because obviously the plant was not suitable for using steel shot. But every plant within his knowledge which had been designed and installed for the use of steel grit had given satisfaction. It was a different matter, however, where a plant had been designed in the first place for using flint grit, and where the operators were accustomed to the use of flint grit. Mr. Hill had mentioned a case in which the grit was lifted by the pressure of the air; but what chance was there of lifting steel grit by that compressed air? It would reduce the efficiency of the plant immediately. If there were to be overhead hoppers for gravity feed there must necessarily be elevators. The results to be obtained with sandblasting apparatus could be foretold if the best people were called upon to advise in the first instance.

MR. MCCALLA did not appreciate why variation of the plant itself should be necessary, whether grit or shot were used, because the whole matter was simply that of carrying a medium by means of a jet of air.

Surface Changes

MR. B. B. KENT agreed with Mr. McCalla that the type of plant should not make very much difference to the achievement of success with either type of abrasive, because the fan of practically any plant could be speeded up to take care of the increased weight of the dust. Another point to be borne in mind was that, when sand was used, the operator could see more easily when the work was clean; if shot were used, the operator must be more of an expert in order to see which part of a casting had been treated, or possibly he had to remember which parts had been treated. The parts treated with sand had a bright, yellowish colour which contrasted with the parts which were not treated; but if steel shot were used, unless the light were exceptionally strong, an inexperienced man might treat parts of a casting two or three times owing to the difficulty of determining visually which parts had been done. Perhaps that was the reason why some people held that treatment with steel shot occupied a greater length of time than treatment with sand.

High Pressures Advocated

MR. HILL emphasised that, in order to produce satisfactory surfaces on castings for vitreous enamelling, the blasting pressure must be high, and it was his considered opinion that the pressures used were not sufficiently high in this country. He appreciated that compressed air was most expensive, but pointed out that in America the minimum pressure used was 100 lbs., and a grit of very fine grade indeed was used. That was not economical from our standpoint, because the grit would be carried away into the dust stream; but, after all, the Americans did secure the output. It must not be thought for a moment that a metallic abrasive could be used in any plant at low pressure to produce surfaces on castings suitable for vitreous enamelling, because one could not do that. He did not think a suitable surface could be produced at any pressure below 45 lbs. That was a matter governing output as well as surface.

MR. MCCALLA said that, if black specks were caused as the result of using steel shot as an abrasive, they must be due to minute portions of metal adhering to the castings. Therefore, the mere cleaning of the shot did not help, because the particles were still left on the castings; they were placed there in the first instance by impact.

MR. HILL said he understood the theory to be that as the abrasive came from the nozzle and made contact with the casting it collected upon itself a small particle of the casting—possibly graphite—as the result of its impact; then, having passed through the various chambers around the plant and back through the nozzle, when it next hit the casting it deposited that particle on the casting again. Therefore, if the abrasive were cleaned as it passed around the plant it would not carry the particle back to the casting.

MR. MCCALLA said that that sounded logical, but did not quite meet his point, which was that the friction set up by the shot hitting the iron of the casting resulted in leaving a minute scale on the casting. The Schoop process of spraying metal on to metal at high pressure relied entirely for its success on the impact and the displacement of air from the surface of the metal, more or less in the same way as electroplating. It was not an alloying process; it was simply that the deposited metal held there because all the air had been excluded and real contact between the metals was obtained. The film of metal was held on by atmospheric pressure, and could not come away.

A Theory for Dirt Inclusions

MR. HILL pointed out that in the blasting process, whether one used flint or metal abrasive, one piece of abrasive followed another and struck the casting in identically the same place. Therefore, if a piece of the surface were displaced by one impact, the next piece of abrasive would remove it, because it was not knocked into the casting sufficiently hard that it would remain there. But when the abrasive came round with that piece of metallic smudge on it, it would drive that smudge into the casting, which had already been subjected to blasting, so that a very rough surface was obtained. The photo-micrographs showed little fissures, and the metallic smudge was driven into those fissures. That was his theory.

MR. HEWISON pointed out that the shot was very hard, whereas the casting, having been annealed was more malleable; he asked if that did not imply that the shot must have a hammering effect and, therefore, close up the surface of the metal, thereby confining some of the impurities in the metal.

MR. HILL replied that that depended entirely on the size of shot. If one used a very large grade of shot, or flint, on an annealed casting, one would produce that hammering effect; but if the right grade were used, that effect would not be produced, whether the casting were annealed or not.

Oil Elimination

MR. HEWISON, referring to the elimination of oil from the flow of compressed air, said he had experimented successfully with an interceptor holding a fair amount of coke. The coke, being porous, absorbed the oil. The coke was not wasted, for it could be used in the boiler furnace afterwards, the interceptor being charged with fresh coke periodically, according to circumstances.

MR. A. B. KENT suggested that the reference to the film on the top of the casting was beside the point, and that one should adjust the dust separator. He could not see how any shot or any flint grit could get into the casting, and surely the exhausting fan should take the dust away. If it did not, then it could be blown off.

MR. E. CHIFFEY said it was certainly essential that the surface of a metal to be metallised should be sandblasted; and, from his experience, he could say definitely that the sprayed metal did not adhere by impact alone.

Differing Applications

MR. HILL pointed out that the problem of metallic *versus* non-metallic abrasives did not arise in connection with metallisation, because if metallic abrasives were used to clean castings for certain forms of metallising the final results were not satisfactory. Whereas in enamelling it was necessary to have fissures in the metal, to give a key to the enamel, such fissures would give rise to bubbles in the metallising process.

Design of Rotary Tables

Further, having in mind the maintenance of sandblast plant, he considered that the method of suspension of the rotary table was wrong. The manufacturers increased the maintenance costs of the rotary table by putting the weight of the table upon the rollers, but, in his opinion, that was equivalent to putting the cart before the horse. He suggested that the weight of the table and its load should be taken by the centre shaft, and the outside rollers should act as jockeys only; he had seen that done in a number of cases with great success. Where the whole weight was borne by the rollers there was excessive wear, and, consequently, increased maintenance costs.

MR. HEWISON asked for Mr. Coupe's experience of blasting aluminium with steel shot.

MR. COUPE replied that steel shot battered the aluminium to pieces.

On the motion of MR. CLAYTON, seconded by MR. HEWISON, a hearty vote of thanks was accorded Mr. Hill for his Paper, and the meeting closed.

* FOUNDRY TRADE JOURNAL. Vol. LI. page 407. *et seq.*

Effect of Copper in Malleable Iron*

By C. H. LORIG,† Columbus, Ohio, U.S.A., and C. A. SMITH,‡ Conn., U.S.A.

[ABSTRACT]

The alloying of copper with malleable cast iron is not new. It frequently occurs as an element not intentionally added, but which enters the iron through its presence in the furnace charge; yet sometimes it purposely may be added, primarily to improve the atmospheric and acid-corrosion resistance of the iron. In either instance, the quantity of copper may be but a few tenths of 1 per cent. which, for the most part, adds little to the mechanical or physical properties. It is when the copper content exceeds 0.70 per cent. that real and important modifications in properties are noted and the iron is sensibly benefited in tensile and yield strength by the added alloying element.

Apart from the improvements to mechanical properties which originate from the presence of copper in malleable cast iron, other benefits accrue from its presence. First, the graphitising reactions, both in the first and in the second stages of graphitisation, are accelerated by copper. This effect, quite analogous to the action on white cast iron of other graphitising elements such as silicon, aluminium, and nickel, is progressively the stronger the more copper that is contained in the iron. Next, the embrittlement sometimes met in malleable cast iron, or susceptibility to intergranular embrittlement at galvanising temperatures, is definitely minimised by the presence of copper. Again, of less widespread and immediate application, though perhaps of considerable technical importance, is the ability of the copper-bearing malleable iron to be strengthened and hardened through precipitation hardening.

Alloying Malleable Iron with Copper

Copper is one of the elements most easily alloyed with iron. It is not oxidised in the melt, therefore none is lost from the metal whether it is contained in the scrap or whether it is added at any period during the process of melting. Its low melting point (1,084 deg. C.) makes it a desirable ladle or spout addition. As much as 1.50 per cent. copper in the form of shot has been added to small ladles of iron with complete solution, uniform distribution, and without seriously lowering the temperature of the metal.

Molten cast iron can take into solution somewhat more than 3 per cent. copper. As this quantity usually exceeds the alloying requirement for the iron, no separation of liquid copper on casting nor any marked segregation of copper will normally occur in copper-bearing malleable-iron castings.

Foundry practice in the manufacture of copper-bearing malleable-iron castings does not differ from that for the normal grade of castings. The introduction of copper makes no appreciable change in casting shrinkage, metal fluidity, or tendency for the castings to crack. Some evidence actually suggests reduction in the cracking tendencies; yet, for the most part, no tangible difference in the behaviour of the alloyed iron in foundry practice is shown.

As copper is a mild graphitising element in white cast iron, certain precautions in the selection of the base analysis necessarily must be followed to avoid mottling or flake-graphite formation. This becomes most serious in the cupola grade of iron where, because of its propensity to mottle even in sections of only moderate thickness, the effect of copper on flake-graphite formation is pronounced, as shown in Fig. 1.

The curves were obtained from observations on the occurrence of mottled areas in various series of step-bar, hard-iron castings poured from two heats of electric furnace iron that resembled cupola iron in composition. Each heat of metal provided six series of step-bar castings differing from one another mainly in their silicon and copper contents. The heat compositions were as follow:—Heat No. 421: C, 2.81; Si, 0.55; Mn, 0.54; S, 0.146; P, 0.137 per cent. Heat No. 422: C, 2.91; Si, 10.43; Mn, 0.58; S, 0.168; and P, 0.150 per cent.

It is obvious that mottling is assisted by the presence of copper,[1] and that for the iron in question each 0.80 to 1.00 per cent. of copper has the equivalent effect of 0.10 per cent. silicon. This relationship between the silicon and copper contents seems to exist for normal air furnace irons as well.

The mere fact that flake-graphite formation in white iron is accentuated by copper immediately leads to the supposition that the graphitisation rate upon annealing should be accelerated by copper. This reasoning is correct.

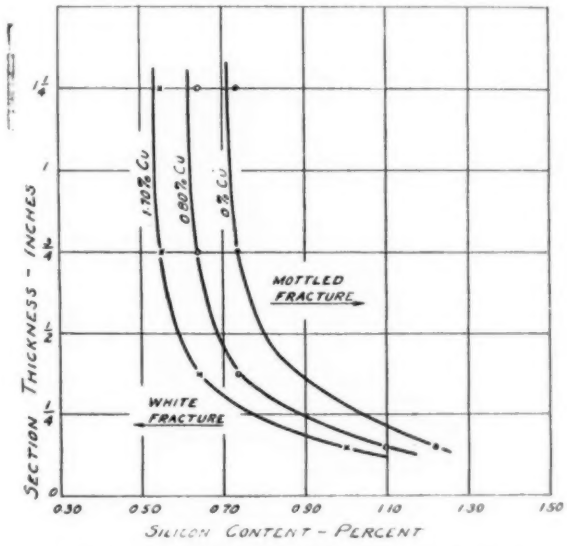

FIG. 1.—RELATION OF SECTION SIZE, SILICON CONTENT AND COPPER CONTENT ON FLAKE-GRAPHITE FORMATION IN HARD IRON CASTINGS.

Effect of Copper on Graphitisation

Malleable irons made in the laboratory and in plant air furnaces and containing various percentages of copper were annealed at given temperatures until all of the primary cementite had been decomposed. Decomposition of cementite was traced by microscopic examination of specimens removed from the furnace and quenched after various periods of heating or by following the expansion of specimens on graphitisation by means of a dilatometer.[2] Typical evidence of the accelerating effect of copper on first-stage graphitisation was obtained on material of the following composition to which none, 1.33, 1.73, and 2.94 per cent. copper was added; C, 2.40; Si, 1.01; Mn, 0.31; S, 0.75, and P, 0.144 per cent.

Expansion measurements by the dilatometer method showed first-stage graphitisation upon prolonged heating at 925 deg. C. to complete itself within the following intervals; no copper, 8 hrs.; 1.33 per cent. copper, 5.2 hrs.; 1.73 per cent. copper, 4.0 hrs.; and 2.94 per cent. copper, 2.4 hrs.

This and other tests have established that the apparent period for first-stage graphitisation within the temperatures of 840 deg. and 925 deg. C. was reduced about 25 per cent. by 1 per cent. copper and about 50 per cent. by 1.5 to 1.7 per cent. copper. Unlike Lykkin,[3] who concluded that copper above 2 per cent. produces no increased effect on first-stage graphitisation, these data show progressive reduction in first-stage graphitisation time with increase in copper content up to at least 3 per cent. It does appear, however, that the acceleration of the rate of graphitisation brought about by copper decreases at some high copper content in white irons.

Using the same white irons as were used in the first-stage graphitisation tests, the time required to complete the second-stage graphitisation was also determined. After being held at 925 deg C. long enough to decompose the primarily cementite, the irons were cooled at a rate of 1 deg. C. per min. to below the critical, and then maintained at 725 deg. C. until all the eutectoid cementite was decomposed. Results are as follow: no copper, 13.2 hrs.; 1.33 per cent. copper, 6.0 hrs.; 1.73 per cent. copper, 5.5 hrs.; and 2.94 per cent. copper, 4.5 hrs. It appears that copper accelerates both stages of the graphitisation equally. Lykkin[3] also confirms this conclusion.

The significance of accelerated graphitisation in the light of plant annealing as generally practised is somewhat more apparent than real. The gain in time of as much as 50 per cent. in the first and second stages of graphitisation is somewhat minimised in its effect on the total annealing cycle by the period required to heat and cool the ovens. Nevertheless, the presence of copper, concomitant with its accelerated graphitisation effect on white iron, would give greater assurance of complete malleableisation under circumstances that normally would produce iron insufficiently annealed.

With the entire production of a foundry on copper malleable iron, advantage of the graphi-

* Paper presented to the International Foundry Congress a Philadelphia.

† Metallurgist, Battelle Memorial Institute.

‡ Research Metallurgist, American Brass Company.

1 Some investigators, notably A. L. Boegehold (U.S. Patent 1,707,753, 1929) and C. S. Smith (unpublished data, American Brass Company) and some work at Battelle Memorial Institute on grey cast irons have shown an increased stabilisation of white iron as the result of small quantities of copper, less than 0.50 per cent.

2 The reliability of the dilatometer method as a means for detecting decomposition of cementite and the completion of the reaction was proved by microscopic examination of the specimens

3 Lykkin, L., "Influence of Copper on the Graphitisation Behaviour of White Cast Iron," Iowa State College, "Journal of Science," vol. 8, No. 1, pp. 207-210, October, 1933.

tising effect of copper to shorten the anneal may be taken with a likely total saving in time, fuel, fixed and capital charges, and so forth, amounting to more than the total cost of the copper at present market prices. With these savings, there is the additional advantage of a product of higher strength, one less susceptible to intergranular embrittlement and one which, for special purposes, may be still further strengthened by precipitation hardening. It is conceivable that the annealing period in large ovens could be shortened as much as 20 per cent. by 1.5 per cent. copper in the iron. Yet, on the basis of utilising the accelerating effect of copper to its fullest degree, perhaps the short-cycle annealing operations offers the greatest opportunities.

TABLE I.—*Mechanical Properties of Malleable Cast Iron Containing Copper.*

Heat. *	Chemical composition, per cent.†					Tensile strength, tons/sq. in.	Yield strength, tons/sq. in.	Elongation per cent. in 2 in.
	C.	Si.	Mn.	P.	Cu.			
1—22	2.36	0.94	0.27	0.132	0.031	27.0	17.0	14.5
1—34	2.31	1.08	0.22	0.109	0.63	26.1	18.5	22.2
1—35	2.27	1.11	0.22	0.106	1.12	27.3	19.8	22.5
1—41	2.38	1.13	0.28	0.128	1.30	26.4	19.5	16.0
1—44	2.36	1.10	0.26	0.124	1.50	26.8	20.1	15.0
1—45	2.33	1.10	0.27	0.122	2.01	26.5	20.1	18.5
1—47	2.34	1.04	0.26	0.119	2.68	26.5	19.5	16.0
2—46	2.43	1.27	0.31	0.141	0.042	22.5	15.6	13.8
2—29	2.29	1.19	0.25	0.105	0.60	25.5	17.9	20.2
2—30	2.31	1.22	0.25	0.110	1.00	26.5	19.2	22.5
2—42	2.29	1.29	0.26	0.138	1.22	26.5	19.8	17.8
2—31	2.36	1.29	0.26	0.123	1.42	26.8	19.8	18.5
2—32	2.34	1.28	0.25	0.122	1.85	27.3	20.5	16.7
2—38	2.26	1.24	0.24	0.125	2.97	26.4	20.2	15.3
3— 9	2.78	0.92	0.27	0.127	0.07	20.0	12.5	9.3
3—10	2.77	0.92	0.25	0.130	0.72	21.5	16.2	9.0
3—11	2.76	1.02	0.28	0.130	1.02	24.0	17.9	8.5
3—12	2.76	1.01	0.26	0.128	1.25	25.0	20.1	9.5
3—13	2.64	0.95	0.25	0.123	1.46	26.2	19.5	9.5
3—14	2.64	0.92	0.24	0.117	2.02	25.9	19.5	12.0

* First number in heat number indicates series. † Sulphur content of the iron ranged from 0.025 to 0.030 per cent.

Mechanical Properties of Copper-Malleable Iron

The presence of copper does not markedly influence the structure of malleable cast iron except that it tends to refine the grain and produce smaller and therefore a greater number of graphite nodules. The effect of copper on mechanical properties must, therefore, chiefly relate to the influence of its presence upon the ferritic matrix. The solid solubility of copper in pure iron at room temperature is variously given between 0.4 and 0.5 per cent. (at 810 deg. C., it is given as about 3.4 per cent.) and all copper in excess of this, if permitted will separate as tiny microscopic or sub-microscopic particles within the ferrite grains. The dissolved copper has only a moderate effect upon the mechanical properties of the malleable cast iron. It is not until more than 0.5 per cent. copper is present that these properties begin to increase materially. The magnitude of the changes continues to increase, until the copper content is about 1.25 to 1.5 per cent. beyond which greater percentages again only moderately affect the properties.

The effect of the percentage of copper on mechanical properties of laboratory-made malleable cast iron is illustrated in Table I. The properties in this table represent averages obtained on two specimens. Bars were cast to pattern similar to one adopted by the Malleable Iron Research Institute. All bars were annealed in a plant oven along with other castings.

Perhaps of greatest interest are the effects of copper on the yield strengths. All irons with more than 1.25 per cent. copper have a yield strength of 19.6 to 20.5 lbs. per sq. in. which is obtained more or less regardless of the quality of the base iron. Provided that no mottled areas appear in the white iron, it remains unchanged to at least 3 per cent. copper. The tensile strength of the irons with 1.25 per cent. copper or more also tend to reach a constant value, about 26.8 tons per sq. in. Disregarding the elongation values of the unalloyed irons of the first and second series, it is generally observed that copper to some degree reduces the elongation values.

The exceptional increase in tensile yield strengths brought about by copper in the third series, the high-carbon iron, is unique and of some industrial importance. Here, by the simple expedient of alloying the iron with 1.25 per cent. copper, a low shrinkage and easily machinable material is made to possess the strength properties of the low-carbon malleable iron. Only its elongation is not improved. Copper is particularly effective in raising the yield and tensile strengths of the weaker high-carbon irons.

While the effect of copper on the mechanical properties of malleable cast iron as here determined was observed on laboratory-made materials, the same general observations are confirmed by tests on a plant-made iron whose average properties are given in Table II. Composition of the iron was 2.40 per cent. carbon; 1.01 per cent. silicon; 0.31 per cent. manganese; 0.075 per cent. sulphur and 0.144 per cent. phosphorus.

TABLE II.—*Mechanical Properties of Commercial Copper Bearing Iron.*

No.	Copper per cent.	Tensile strength, tons/ sq. in.	Yield strength, tons/ sq. in.	Elongation, per cent. in 2 in.	Brinell hardness.
1	0	25.0	16.1	14.0	121
2	1.33	28.6	21.7	12.0	135
3	1.73	28.1	21.0	11.2	134
4	2.25	27.2	21.0	10.0	137
5	2.94	28.1	21.3	9.5	137

In Table II the tensile and yield strengths assume constant values of 27.2 to 28.6 and 21 to 21.7 lbs. per sq. in. respectively, with 1.33 per cent. or more copper in the iron. The Brinell-hardness value increases with copper and does not rise further with the addition of more than 1.33 per cent., and the elongation values progressively fall with copper content. No decided benefits accrue to mechanical properties upon adding more than 1.25 to 1.50 per cent. copper to malleable cast iron.

Endurance Limit.—The endurance properties of malleable cast iron are improved by copper in the same proportion as the tensile strength is increased. That such is the case is shown by values given in Table III for the endurance limit and ratio of malleable cast iron with and without copper.

Modulus of Elasticity.—The modulus of elasticity of malleable cast iron, determined from stress-deformation values, is unaffected by copper.

Intergranular Embrittlement.—There is a definite tendency for copper to reduce the susceptibility of malleable cast iron to "galvanising" or intergranular embrittlement. Its effect is convincingly shown with Charpy impact specimens heat-treated as follows:—(1) As annealed; (2) heated to 450 deg. C. for ½ hr. and water-quenched; (3) heated to 650 deg. C. for 1 hr. and water-quenched; and (4) heated to 650 deg. C. for 1 hr. and water-quenched, reheated to 450 deg. C. for ½ hr. and water-quenched.

In Table IV the Charpy impact values of specimens heat-treated in this manner are the averages obtained on three specimens. The change in impact values of the annealed specimens after they are heated to 45 deg. C. and quenched is a measure of their susceptibility to embrittlement. It will be noted from Table IV that losses in impact resistance after this treatment are effectively reduced by copper. None of the irons is susceptible to embrittlement after the generally applied corrective treatment of quenching from 650 deg. C.

Whilst tensile properties remain relatively unaltered with quantities of copper above 1.25 to 1.50 per cent., it may require several per cent. copper to ensure freedom from intergranular embrittlement in some malleable cast irons. The evidence is ample that copper modifies intergranular embrittlement in malleable cast iron of variable silicon and phosphorus contents. Copper is not a cure for intergranular embrittlement, but the modification and suppression of the embrittlement which it effects are of considerable industrial importance and, if full use is made of its action, the amount of malleable iron which must be specially heat-treated before zinc-coating or galvanising to ensure freedom from embrittlement would be enormously reduced.

Because of the decreasing solubility of copper in iron (from about 3.4 per cent. at 810 deg. C. to about 0.5 per cent. at room temperature), certain copper-bearing malleable irons are amenable to precipitation hardening. However, to have them respond to these treatments they must contain more than the maximum amount of copper which is soluble in iron, under equilibrium conditions, at room temperature. Usually, no hardening is experienced with a copper content less than 0.65 per cent.

Precipitation Hardening in Copper-Malleable Cast Iron

Some improvements in strength and hardness are gained merely by reheating the annealed iron for several hours at 454 to 538 deg. C., but to harden the iron effectively by subsequent precipitation, a solution treatment to dissolve a reasonable quantity of copper, should precede the reheating. The solution heat-treatment to

TABLE III.—*Effect of Copper on Endurance Properties of Iron.*

Chemical composition.				Endurance properties.		
C.	Si.	Mn.	Cu.	Endurance limit, tons/sq. in. (A).	Tensile strength, tons/sq. in. (B).	Endurance ratio, $\frac{A}{B}$
2.43	1.27	0.31	0.042	12.0	22.5	0.535
2.48	1.10	0.31	1.24	13.4	27.0	0.498
2.26	0.90	0.28	1.12	14.3	25.7	0.554

dissolve some of the copper precipitated during the slow cooling following the anneal should be carried out at a temperature just below the lower critical temperature. This avoids carbon absorption, yet permits a substantial solution of copper. Copper is retained in solution even at reasonably slow rates of cooling as, for instance, during air-cooling.

By reheating the solution-treated irons to 454 to 538 deg. C. for a time determined by the temperature and the degree of hardening sought, copper (according to the usual explanation of precipitation-hardening phenomena) is precipitated as particles of sub-microscopic size. These disseminated particles produce hardening of the irons and increase their tensile and yield strengths. A few data are included in Table V to demonstate the precipitation-hardening effect in specimens of iron that were given a solution treatment for 1 hr. at 730 to 745 deg. C., then reheated for 3 hrs. at 500 deg. C.

TABLE IV.—*Charpy Impact Values of Malleable Iron Showing Effect of Copper on Inter-Granular Embrittlement.*

Heat No.	Chemical composition.					Average Charpy impact values, ft.-lb.			
	C.	Si.	Mn.	P.	Cu.	Annealed.	Heated to 450 deg. C. and quenched.	Heated to 650 deg. C. and quenched.	Heated to 650 deg. C. and quenched; reheated to 450 deg. C. and quenched.
46	2.43	1.27	0.31	0.141	0.042	4.8	0.8	4.9	5.3
29	2.29	1.19	0.25	0.105	0.60	8.1	3.2	7.8	8.3
30	2.31	1.22	0.25	0.110	1.00	8.0	7.1	7.9	8.2
42	2.29	1.29	0.26	0.138	1.22	7.2	4.8	6.9	7.1
31	2.36	1.29	0.26	0.123	1.42	7.3	5.3	6.8	7.2
32	2.34	1.28	0.25	0.122	1.85	7.0	5.6	7.1	7.5
38	2.26	1.24	0.24	0.125	2.97	6.9	6.2	7.1	7.3
1A	2.36	0.92	0.32	0.206	0	4.4	2.2	—	—
3A	2.36	0.92	0.32	0.206	1.23	5.4	3.2	—	—
5A	2.36	0.92	0.32	0.206	1.92	5.7	5.1	—	—
7A	2.36	0.92	0.32	0.206	2.84	5.8	5.4	—	—
9A	2.36	1.17	0.32	0.206	0	5.7	2.6	—	—
11A	2.36	1.17	0.32	0.206	1.17	5.2	2.7	—	—
13A	2.36	1.17	0.32	0.206	2.01	5.2	4.3	—	—
15A	2.36	1.17	0.32	0.206	3.20	5.6	4.5	—	—

In Fig. 2 the changes in properties which occur upon precipitation hardening, subsequent to the solution treatment, are plotted in relation to the copper contents of the irons. The abruptness in the trend of the curves between 0.63 and 1.25 per cent. copper is distinct evidence of the precipitation-hardening effect. The average tensile and yield strengths and hardness

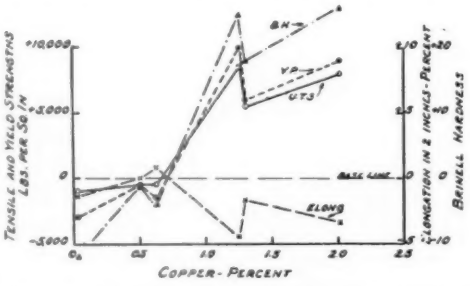

FIG. 2.—CHANGES IN PROPERTIES OF MALLEABLE CAST IRON CONTAINING COPPER.

Solution treatment for 1 hr. at 730 to 745 deg. C. Followed by precipitation hardening for 3 hrs. at 500 deg. C. Properties of the solution treated irons used as a base. Plotted values are differences between these properties and the properties after precipitation hardening.

of the malleable cast irons are slightly increased, and the elongation practically unaffected by the solution treatment, indicating that a rather small amount of carbon was redissolved and that part of the copper had been brought into solution at the temperature chosen. Some precipitation hardening occurred on reheating for 3 hrs. at 500 deg. C. Malleable irons containing 0.6 per cent. copper or less showed no alteration in properties, but those containing 1 per cent. copper or more had their tensile and yield strengths increased by one to four tons per sq. in. with only a small though noticeable reduction in elongation.

While it may be impracticable for many casting manufacturers to take advantage of the precipitation-hardening effect of copper in malleable iron with their present equipment, nevertheless this potential source of increased strength is available. It is suggested that materials so treated may eventually prove themselves of value as readily machined high-strength irons.

From the data presented, it would appear that a malleable iron of about C 2.35, Si 1.10, Cu 1.25, Mn 0.30, S 0.07 and P. 0.15 per cent., in plant production, should allow cutting 10 hours off the annealing time (3 hours in the first stage and 7 hours in the second stage of graphitisation at an annealing temperature of 925 deg. C.). The material should have about 26.4 tons per sq. in. tensile strength, 19.5 tons per sq. in. yield strength, 13.4 tons per sq. in. endurance limit, 16 to 22 per cent. elongation, and 130 Brinell hardness, and should possess acceptable resistance to galvanising embrittlement without quenching.

By solution and precipitation treatments, the material could be brought to 29 tons per sq. in. tensile strength, 24.3 tons per sq. in. yield strength, 14 per cent. elongation, 160 Brinell hardness.

TABLE V.—*Mechanical Properties of Precipitation-Hardened Malleable Cast Iron.*

Heat No.	Chemical composition.					Tensile strength, tons/sq. in.	Yield strength, tons/sq. in.	Elongation, per cent. in 2 in.	Brinell hardness.	Treatment.
	C.	Si.	Mn.	P.	Cu.					
22	2.36	0.94	0.27	0.132	0.031	27.0	17.0	14.5	121	Annealed
						28.1	19.5	17.7	133	730–745 deg. C.
						27.7	18.4	16.3	121	Reheated 500 deg. C.
34	2.31	1.08	0.22	0.109	0.63	26.1	17.8	22.2	121	Annealed
						27.2	20.3	23.7	134	730–745 deg. C.
						27.0	19.5	24.5	130	Reheated 500 deg. C.
41	2.38	1.13	0.38	0.128	1.30	26.1	19.5	15.5	128	Annealed
						26.8	21.5	15.7	141	730–745 deg. C.
						29.1	24.3	14.0	159	Reheated 500 deg. C.
45	2.33	1.11	0.27	0.122	2.01	26.5	20.1	18.5	128	Annealed
						27.7	22.4	18.5	139	730–745 deg. C.
						31.2	26.4	15.2	165	Reheated 500 deg. C.
12	2.76	1.01	0.26	0.128	1.25	25.0	20.1	9.5	128	Annealed
						25.2	21.0	11.5	134	730–745 deg. C.
						29.0	25.5	7.2	159	Reheated 500 deg. C.
29	2.29	1.19	0.25	0.105	0.60	25.5	17.9	20.2	122	Annealed
						26.4	20.1	22.7	134	730–745 deg. C.
						26.8	19.8	22.7	133	Reheated 500 deg. C.

The question might be raised whether the improvement in the yield strength from, say, 16.2 to 19.5 tons per sq. in. by the use of copper could not be brought about without expense; in other words, whether the saving due to decrease in annealing time would not at least balance the cost of copper and justify putting copper into the whole product of a given plant, so that the annealing schedule could make use of the quick-annealing properties of copper malleable without having to be held back to accommodate slower-annealing non-alloyed malleable. The further increase to 24.3 tons per sq. in. yield strength could be obtained by precipitation hardening if desired. While the elongation is somewhat decreased as these improvements in yield strength are obtained, the serviceability for uses where toughness is required is not decreased, as judge by impact resistance or by the area under the stress-strain diagram.

To the virtues of reasonable toughness and ready machineability of ordinary malleable, copper-alloyed malleable adds that of a yield strength equal to that of the regular grade of annealed carbon-steel casting.

Summary

The foregoing statements may be summarised as follow:—

(1) Copper is easily alloyed with the iron in the ladle or spout.

(2) Molten iron can take into solution at least 3 per cent. copper.

(3) Three-tenths per cent. copper adds little to the mechanical or physical properties of malleable iron, but 0.7 to 1.25 or 1.50 per cent. benefits it.

(4) Copper does not change the fluidity or shrinkage of iron, nor does it increase cracking. The structure is not markedly influenced by copper.

(5) Graphitisation is considerably accelerated by copper, equally in the first and second stages, and the cost of the copper may be overbalanced by the benefits derived.

(6) Copper improves the endurance properties of iron and reduces its susceptibility to intergranular embrittlement.

(7) Mechanical properties of malleable iron with seven-tenth per cent. or more copper are improved by precipitation-hardening.

(8) Plant tests confirmed the findings of laboratory tests.

Acknowledgment

The writers wish to express their appreciation to the following:—The Copper and Brass Research Association; E. W. Palmer; A. W. MacLaren; D. E. Krause; and the Ohio Malleable Company.

Impressions of American Foundry Practice

DISCUSSION ON MR. MAKEMSON'S PAPER

During his visit to the United States of America on the occasion of the recent International Foundry Congress, Mr. Makemson sent along to the FOUNDRY TRADE JOURNAL very full reports which he used as a basis for his lecture to a meeting of the Lancashire Branch of the Institute of British Foundrymen, held in the Engineers' Club, Manchester. Mr. W. N. Cook, the Branch-President, was in the chair.

An interesting discussion followed the lecture.

MR. F. HARRIS (Padiham) proposed that a hearty vote of thanks be accorded Mr. Makemson, which MR. W. HOLLAND (Manchester) seconded. It was carried unanimously by acclamation.

MR. MAKEMSON briefly responded to the vote of thanks.

Cupola Melting Non-Ferrous Metals

MR. A. L. KEY (Stockport) asked whether he understood correctly that copper, lead and tin were all melted together in the cupola. The reason he asked the question was because in his younger days he worked at an important establishment where there were large castings produced up to 14 cwts. of gun-metal, all cupola-melted metal, and which was only melted with the zinc and the copper. One would imagine that by melting the lead through the cupola the loss would be serious. Was it the practice to add the lead and the zinc afterwards, or was the whole mix melted directly in the cupola?

MR. MAKEMSON replied that the question had rather raised a doubt in his mind. Certainly the melting of the lead and the tin did seem to be extraordinary. The copper certainly was melted. He was under the impression that the other two were also, but he would not like to be definite about it.

MR. JOHN MASTERS (Shrewsbury) said, with respect to the addition of copper to the alloy for making the crankshafts, there was a firm in this country making practically an identical mixture in a rotary furnace, and they were getting approximately the same tests as the Ford people, namely, 42/43 tons tensile. They were also adopting the heat-treatment, and the copper was added in the rotary furnace.

MR. MAKEMSON said the crankshaft cores were made with a mixture of 60 per cent. new sand and 40 per cent. reclaimed sand. The bond was oil, together with a small amount of dry binder added to give strength during the green stage, but he did not know of what it was composed.

MR. REYNOLDS asked if the Wheelabrator only used sand or whether shot was used also.

MR. MAKEMSON replied that both were used; the shot more commonly than sand.

MR. A. SUTCLIFFE (Bolton) asked what was done with all the dust that was collected. Did it go into the atmosphere?

MR. MAKEMSON said that the dust was certainly not sent into the atmosphere. The ventilators referred to apparently drew in clean air. Possibly some fumes might go out into the air, but apparently not the dust from, say, sand-blasting, fettling, and other dusty processes. Exactly what did happen to it he could not say, but he should imagine it was all driven into a sump or a tank in order to prevent it getting into the air again.

Low-Carbon Cast Iron

MR. C. A. HOWE (Manchester) was interested to learn it was actually the fact that the Ford analysis was 1.25 carbon. It was very difficult to obtain 1.25 carbon in cupola-melted iron. Was it the refining, which afterwards took place, that removed the carbon?

MR. MAKEMSON said that the carbon was definitely as low as 1.25. This was why some people called it steel. Other people, looking at the silicon content of 2 per cent., called it cast iron. The low carbon content was obtained after the cupola-melting either in the electric furnace or in the air furnace which was substituted in place of the electric furnace. It was essential that there must be a low carbon content.

MR. HARRIS asked what was Mr. Makemson's view with regard to the working speed of the American moulder; whether he was speedier than the British moulder, having regard to the fact that he was equipped with all the latest modern developments in the way of rammers, vibrators, etc.

MR. MAKEMSON replied that it was very difficult for a casual visitor to America to make up his mind upon such a point. One met people who had been working in American foundries for years, and still were not quite sure as to which of the two was the better type of moulder. The moulders in the jobbing foundries were skilled men, as distinguished from those men engaged upon repetition work. Even in the jobbing foundries, however, the men were equipped with all kinds of mechanical gadgets, such as mechanical riddles, rammers, chippers, etc. The idea was to eliminate the donkey work from moulding, and leave the moulder to mould. Personally, he did not know whether the American moulder was a better man than the British type. All the methods appeared to be exactly alike, and the way in which the American moulder went about his work was exactly similar to the way in which it was done in this country.

The N.R.A. Codes

MR. A. L. KEY asked whether it had been possible to obtain any information with regard to relative production costs and selling prices; in other words, what was the minimum amount of remuneration allowed in the way of profit? Was there a code laid down?

MR. MAKEMSON said that codes could be bought from the American publications department, and that they were published from time to time in the American foundry Press. He did not obtain any actual figures with regard to selling prices. They had not been refused to him, and there did not appear to be any particular secrecy about them; the fact of the matter was that he had not been interested in that particular direction. He was more concerned with the technical layout of the foundries. To the great mass of working people the "new deal" represented something for nothing in the form of increased wages and shorter hours, but manufacturers and heads of works who had to find the money were considerably hampered thereby.

Safety Clothing

MR. R. A. MILES (Manchester) asked what kind of clothing the workmen wore in the foundries in U.S.A.

MR. MAKEMSON said that they mostly wore overalls. He did not see any mole-skins, though he saw some corduroys. One thing he noticed was that everybody in the foundry who had got anything to do with the handling of metal, such as cupola men, men who tapped, moulders, etc., used asbestos clothing. Everyone used asbestos spats, and some other garments as well. Even the foremen walking about the foundry wore asbestos spats.

The World's Fair

MR. MAKEMSON said he would have liked to have said a good deal about the World's Fair at Chicago. This exhibition is the most colossal show ever attempted in the world, and it stretches along the shore of Lake Michigan for 3½ miles. After usual banking hours, in the evening, the money taken at the various shows is collected by officials who are driven round in a peculiar kind of armoured motor wagon protected with heavy steel plates. Both the driver and the guard of the car are armed with revolvers, and the car is so constructed that if anyone attempts to open it heavy clouds of poison gas are immediately released. He had been told that if such precautions were not taken it would not be possible to deliver the cash to the central vault provided for its reception.

A Further Impression

MR. E. LONGDEN (Manchester) observed that the American moulder was usually a man trained by British instruction, and he was certainly a man of very high ability. It should be borne in mind that the speed of the American moulder was largely determined by the many mechanical aids which were provided to assist him. Donkey work had certainly been largely taken out of the hands of the American craftsmen. Quite contrary to the impression of British people who have not visited the States, the American moulder did not appear to work any harder than the Britisher. As a matter of fact, he, the speaker, found very few workpeople who worked really as hard as the workpeople of the Old Country. He would like to refer to the crankshafts mentioned in the course of the lecture. He had seen very many of them, and they were a wonderful piece of work. It had been said that there was no machine tool made which was able to produce an accurate crank shaft. Both in the case of motor-car engines and aircraft engines it was not possible to make a crankshaft "stay put." Owing to the forging there was considerable tendency to twisting and changing. The Ford type of crankshaft was much better and much more stable. He had been very pleased to listen to the remarks of Mr. Makemson; they had revived pleasant memories of the time when he himself was in America.

Competition from Weldings

MR. MAKEMSON, in his concluding remarks to the discussion, referred to welding competition in the U.S.A. General foundries, such as those of Allis-Chalmers and some others, were certainly feeling the effects of welding competition to a large extent. A considerable number of components which were made in the form of castings were now being made as weldings. This was mainly the case with foundries that were making fairly large pieces in small quantities of the one-off or two-off variety. The repetition people were not feeling the competition at all. There appeared to be a strong tendency carefully to discriminate between jobs that ought to be welded and jobs that ought to be cast. The Harnishfeger Company was a case in point. In regard to their "Bucyrus" excavator, they still used a considerable number of steel castings, although the firm itself actually made welding sets or apparatus. Welding apparently would not stand up to the gruelling conditions which some of the excavators had to face. The Allis-Chalmers Company were doing a fair amount of welding, but they also found there were many things it was better not to weld. Nevertheless, there was more welding going on in the States than one cared to see.

Welfare Activities

In reply to MR. R. A. MILES, the LECTURER said that the Welfare Centres at most of the works visited were not as good as those which were customary in this country. It was not usual to find large canteens provided for the workpeople. There was a very fine one at the General Motors Foundry, but in most cases the men seemed to eat by the side of the machines. There was a *cafeteria* provided, where they could go and buy buns and a cup of tea, and also shops where they could buy things, but, generally speaking, there were no large dining

(*Concluded on page 97*)

Basic Requirements for Industry

MR. ROY STUBBS' VIEWS

Over 180 ladies and gentlemen were present on Saturday, January 19, at the annual dinner of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen. Held at the Imperial Hotel, Birmingham, under the chairmanship of the Branch-President (Mr. G. T. Lunt), it was the most successful of the long series. The company included Mr. Roy Stubbs (President of the Institute), Mr. J. E. Hurst and Mr. H. Winterton (Vice-Presidents), Mr. Tom Makemson (Secretary), Mr. C. R. F. Engelbach, O.B.E., a director of the Austin Motor Company, and Mr. T. J. Kennedy (President of the Birmingham Chamber of Commerce). Mr. E. J. Lewis (ex-Branch-President) acted as toast master. Following the dinner there was a dance and whist drive.

A Changed Industry

The toast of the Institute was submitted by Mr. C. R. F. Engelbach, who said he knew of no technical body which did more for the benefit of the industry which it represented. When he served in the foundry, before the foundation of the Institute in 1904, there was a great deal of mystery and very little science in foundry practice. A few years ago he used to say that the foundry was a hundred years behind the times, but since his own foundry had been mechanised he was inclined to think that they were in advance of the times. Now that the Institute had familiarised everyone with the processes, there is no longer any need to invoke the aid of the Deity, or to attribute the amount of scrap made to an Act of God. He congratulated the Institute upon having a gentleman of the eminence of Mr. Roy Stubbs as President. In technical institutions it was not always that they had a practical man as President. There were sometimes figureheads. In Mr. Stubbs they had one of the leading foundrymen of Great Britain. He came of a family of foundrymen, and he was certain the Institute would derive the greatest benefit from having Mr. Stubbs at the head of affairs.

Factors for Progress

Mr. Roy Stubbs, who had a very cordial reception, responded. He complimented Mr. L. W. Bolton on his successful work as Hon. Secretary of the Branch, and thanked Mr. Engelbach for his good wishes for the prosperity of the industry. It was an especial honour, he said, to have the presence of so distinguished an engineer. They were very proud to know that the product of the foundry industry was one of the vital parts of a car, and prouder still that the Institute had played its part in contributing to the enormously high efficiency that was called for to-day. The automobile engineer and the foundryman were both connoisseurs; they both affected a special knowledge about a special commodity, and charged a special price. He wanted particularly to thank Mr. Engelbach, and ask him to convey their thanks to Sir Herbert Austin and his co-directors, for their many acts of kindness to members of the Institute. They appreciated the support of the Austin Company, and hoped that it would continue.

It seemed to him that there were some very definite needs in an industry—firstly, a strong technical institute which, of course, they had in their own Institute; secondly, a strong technical Press, which they had in the FOUNDRY TRADE JOURNAL, in which so much information of incalculable value, supplied by the Institute, was published, (its Editor gave an enormous lot of help in an unseen way behind the scenes); and thirdly, a strong Research Department, which he claimed they also had. The Technical Council, under the able guidance of Mr. Gardom, was progressing by leaps and bounds, and its published conclusions left no doubt at all that it had some extremely able members in its personnel. It might not be generally known that if any member of the Institute had a problem in his foundry he could not solve, or any question of foundry practice upon which he needed advice, he could send it to the Technical Council, who would give him expert advice, and the matter would be guaranteed to be definitely confidential. That was just one item of service the Institute rendered among others too numerous to mention. He urged them to avail themselves to the full of the services it had to offer. In so doing they would increase its activities, and he felt sure extend its membership. Another strong need of an industry was a trade Association, but that did not come within their province that night. These points, he thought, clearly showed that the Institute was alive and constantly progressing to meet the ever-increasing demands made by the engineer for better products, and that in every way the Institute was equal to the demands made upon it. He wished the Branch and its President continued prosperity and success.

Science to Supersede Salesmanship

MR. T. J. KENNEDY, in proposing the toast of "The Birmingham, Coventry and West Midlands Branch," said the Institute had flourished for 31 years, and he was glad to think that in the Birmingham district there was such an active and successful branch. For himself, he was a strong adherent of trade associations, both commercial and technical, so long as they were guided by an enlightened policy and always having due regard to the interest of the consumer. He was pleased to know that there was an exchange of ideas with the non-ferrous trade. Such an interchange was all to the good. There was a time when everything was kept secret and people worked in watertight compartments. All that was different now, and he believed they were entering upon an age of co-operation. They had all heard a great deal about the value of advertising, and he believed there was truth in the claims made so far as articles in common use, such as motor cars and safety razors, were concerned. But he was not sure that the same held good in the case of basic trades. So far as they were concerned, it was to science rather than to salesmanship that they must look for the great development they all hoped the future had in store for them.

The CHAIRMAN (Mr. Lunt), responding, said the Birmingham Branch had a number of things to its credit in the past. It was credited with having been the cradle of the Institute, and in 1931 it staged a very good conference under the presidency of Mr. A. Harley. He was glad to say that the Branch was not resting on its laurels. The membership to-day was the largest in its history, while the dinner that night broke all records in numbers. It was rather interesting to compare the 180 or more present on that occasion with the dinner twenty years ago, when the attendance was 35. The success of the Branch was due, of course, not to the figurehead but to the Branch Council who have time for thought, year in and year out, to the conduct of the Branch. Reference had been made to the secretary (Mr. L. W. Bolton), to whom they owed a great deal. They particularly welcomed among them Mr. Roy Stubbs, who bore an honoured name. "I suggest to you," the chairman added, "that he does honour to his name and that we welcome him not only for the sake of his ancestors but for his own sake and because of his personal achievements."

MR. D. H. WOOD proposed the toast of "The Guests," to which MRS. ROY STUBBS replied in a neat speech.

Institute of Metals

ANNUAL GENERAL MEETING

The twenty-seventh annual general meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1 (by kind permission of the Council of the Institution), on March 6 and 7. The following is a list of the Papers to be presented:—

"Corrosion-Fatigue Properties of Duralumin With and Without Protective Coatings," by I. J. Gerard, M.Sc., and H. Sutton, M.Sc.

"Some Further Experiments on Atmospheric Action in Fatigue," by H. J. Gough, M.B.E., D.Sc., F.R.S., and D. G. Sopwith, B.Sc.Tech.

"The Effect of Five Years' Atmospheric Exposure on the Breaking Load and the Electrical Resistance of Non-Ferrous Wires," by J. C. Hudson, D.Sc.

If time permits:—

"The ϵ, γ and β Phases of the System Cadmium Silver," by P. J. Durrant, M.A., Ph.D.

"The Penetration of Steel by Soft Solder and Other Molten Metals at Temperatures of not over 400 deg. C.," by Dr. Ir. L. J. G. Van Ewijk.

"Type Metal Alloys," by Frances D. Weaver, B.Sc.

"The Constitution and Properties of Cadmium-Tin Alloys," by Prof. D. Hanson, D.Sc., and W. T. Pell-Walpole, B.Sc.

"Some Properties of Tin Containing Small Amounts of Aluminium, Manganese or Bismuth," by Prof. D. Hanson, D.Sc., and E. J. Sandford, B.Sc.

"The Reduction by Hydrogen of Stannic Oxide Contained in H.-C. Copper," by W. E. Alkins, D.Sc., and A. P. C. Hallowes.

"Unsoundness in Aluminium Sand-Castings. Part III.—Solidification in Sand Moulds under Pressure," by Prof. D. Hanson, D.Sc., and I. G. Slater, Ph.D., M.Sc.

"Alloys of Magnesium. Part II.—The Mechanical Properties of Some Wrought Magnesium Alloys," by W. Prytherch, M.Sc.

"The Spectrographic Analysis of Aluminium," by D.M. Smith, B.Sc.

The annual dinner and dance will be held at the Trocadero Restaurant, Piccadilly Circus, W.1, on March 6.

A visit will be made to the Battersea Power Station on March 7. A motor 'bus will leave St. Ermin's Restaurant at 2.15 p.m. promptly for Battersea, the visit being due to begin at 2.45 p.m. and to conclude about 4.15 p.m., when the 'bus will return to its starting point (adjoining St. James's Park Underground Station).

Impressions of American Foundry Practice

(*Concluded from page* 96)

rooms. Saginaw, where the General Motors Foundry was situated, was quite a small town, and possibly men living in such small towns appreciated welfare work better than men living in great cities, where there was greater scope for the satisfaction of their needs. There was an excellent spirit of comradeship and goodwill noticeable right throughout the foundry at Saginaw. One phase of welfare work that was catered for extremely well in the States was the works hospital, as it was termed, and which in this country would be termed an ambulance room. Many works had a doctor and nurses in constant attendance, and the "hospitals" were extremely well fitted up. In many works the workpeople submitted themselves periodically for medical examination of teeth, the heart, etc.

XUM

Employment in 1934

IRON, STEEL AND ALLIED INDUSTRIES

The "Ministry of Labour Gazette," in its review of employment, wages, hours of labour, etc., in 1934, points out that the marked improvement in employment which occurred in 1933 continued during the early months of 1934. There was the usual seasonal recession in January, but from the end of that month until the middle of May the level of employment rose continuously. During the summer and early autumn, the improvement was checked, and at the end of October the total number of insured persons in employment showed only a slight advance upon that recorded in May. In November and December, however, the improvement was resumed, although at a rate considerably slower than in the corresponding period of 1933. Between December 18, 1933, and December 17, 1934, the total number of insured persons, aged 16-64, in employment increased by 237,000. The figure for December, 1934, was higher than at any previous December for which figures are available, and, moreover, was exceeded in only seven months of the year 1929. The average for the year 1934, viz., 10,136,000, showed an advance of 455,000 over the figure for the previous year, and was higher than that for any earlier year except 1929. The average proportion of insured persons unemployed in Great Britain during 1934 was 16.6 per cent., as compared with 19.8 per cent. in 1933. In Great Britain and Northern Ireland the corresponding proportion in 1934 was 16.8 per cent. (wholly unemployed 13.9 per cent., temporarily stopped 2.9 per cent.), and in 1933 was 19.9 per cent. (wholly unemployed 16.4 per cent. temporarily stopped 3.5 per cent.). The number of unemployed persons (insured and uninsured) on the registers of Employment Exchanges at December 17, 1934, was 2,150,741 (1,857,377 wholly unemployed, including persons normally in casual employment, and 293,364 temporarily stopped), as compared with 2,287,466 (1,973,978 wholly unemployed and 313,488 temporarily stopped) at December 18, 1933. The numbers wholly unemployed (including persons normally in casual employment) decreased rapidly from January to June, and there was a further slight decrease between June and July; in the whole of the six months the decrease amounted to 409,299. Thereafter, up to November, the numbers wholly unemployed rose, but the total increase in these four months amounted to 184,075 only, of which about one-half was attributable to the seasonal decline in various trades. Between November and December the movement was reversed, and the numbers wholly unemployed decreased by 12,869. The numbers temporarily stopped decreased from January to March, and then increased to July, the largest monthly increase amounting to 106,807 between May 14 and June 25. Thereafter there was a continuous decrease, of which 103,845 was recorded between August and September. A large proportion of these changes in the numbers temporarily stopped is attributable to seasonal fluctuations in coal mining and to holiday stoppages, particularly in the textile trades.

The normal seasonal improvement in employment which occurs in the first half of the year was accompanied in 1934 by an improvement in many industries not ordinarily subject to seasonal influences, though the improvement was not so widespread as in 1933. On the other hand, the seasonal decline which usually is experienced in the latter half of the year was largely neutralised by a continued improvement in other industries. Apart from these seasonal fluctuations, employment in the metal trades showed on the whole steady improvement throughout the year. In the iron and steel industries, general engineering, and shipbuilding and ship repairing there was an almost continuous reduction in the numbers of persons unemployed, the only material set-back occurring in the iron and steel trades in August.

Pig-Iron and Steel Manufacture

All the metal trade groups, except tinplate manufacture, showed an improvement during the past year. In pig-iron manufacture, the percentage unemployed among insured workpeople, aged 16-64, decreased from 34.7 in December, 1933, to 22.3 in December, 1934, the average for 1934 being 25.2, compared with 38.9 in 1933. The number of furnaces in blast increased to 101 in May, but thereafter declined; nevertheless a monthly production of over half-a-million tons was maintained from that month until the end of the year, and the average monthly production was 498,200 tons, as compared with 344,700 tons in 1933, 515,600 tons in 1930, 669,500 tons in 1920, and 855,000 tons in 1913.

In iron and steel manufacture, employment continued to improve; the percentage of insured workpeople, aged 16-64, unemployed fell from 28.6 in December, 1933, to 23.7 in December, 1934, and the average for 1934 was 25.8, as compared with 38.0 in 1933. The average monthly production of steel ingots and castings was 738,300 tons, as compared with 585,300 tons in 1933, 608,300 in 1930, 755,600 in 1920, and 638,600 in 1913.

Engineering and Shipbuilding

In the engineering industry, employment in 1934 showed a substantial improvement over the level of 1933; the greater part of the improvement, however, occurred in the first half of the year. The average percentage unemployed among insured workpeople, aged 16-64, for the year was 14.6, compared with 23.1 in 1933, and 27.2 in 1932. The improvement was distributed over all branches of the industry, but was most noticeable in those branches in which unemployment in the previous year was relatively high, viz., general, marine and constructional engineering. The percentage of insured persons, aged 16-64, unemployed in the various sections at December 18, 1933, and December 17, 1934, respectively were:—General engineering, 20.0 and 13.7; electrical, 10.6 and 6.9; marine, 40.2 and 28.6; constructional, 28.1 and 20.6; motor vehicle, cycles and aircraft, 11.0 and 8.1.

In shipbuilding and ship repairing, employment showed some improvement, particularly in Scotland and Northern Ireland, but was still depressed. The average percentage unemployed among insured workpeople, aged 16-64, in Great Britain and Northern Ireland was 49.1 in 1934, as compared with 59.3 in 1933; in Scotland and the North-East Coast, the corresponding percentages for 1934 were 57.3 and 65.2 respectively. The tonnage of merchant ships under construction in each quarter of 1934 showed substantial increases as compared with the corresponding quarters of 1933.

Wages

The gradual decline in the general level of wage-rates, which had been in progress since the early months of 1927, was arrested in 1934, the net effect of all the changes reported during the year having been a rise, estimated at about 1 per cent., in the average level of weekly full-time rates of wages. In the industries and services for which detailed statistics are available, the changes in rates of wages in 1934 resulted in an aggregate net increase of £93,900 in the weekly full-time rates of wages of 1,332,700 workpeople, and in a net decrease of £4,100 in those of 87,000 workpeople. The net result of all the changes reported was, therefore, an increase of £89,800 in the weekly full-time rates of wages of the workpeople in the industries and services covered by the statistics. Nearly half of the net increase in rates of wages in 1934 occurred in the coal-mining and transport industries; while, of the decreases, more than half the amount and more than three-quarters of the number of persons affected were in the iron and steel industry.

Rates of wages were increased during 1934 in iron mining in Cleveland and Northamptonshire, in pig-iron manufacture in Cumberland (higher-paid men), Cleveland, North Lincolnshire, Northamptonshire, and (for day-wage men only) in the West of Scotland; higher-paid men engaged in iron puddling and iron and steel rolling in the Midlands and in steel-sheet rolling and galvanising; light-castings manufacture; and in hollow-ware manufacture.

Among the more important groups of workpeople whose rates of wages remained generally unchanged were the following: Blast-furnacemen in Staffordshire and Nottinghamshire; iron and steel workers in South Wales and Monmouthshire; steel workers at Sheffield; workpeople in the engineering, shipbuilding and ship-repairing industries; tinplate workers in South Wales and Monmouthshire; constructional engineering workers; and those engaged in chain making and in various other metal industries.

Copper Difficulties

By "ONLOOKER."

For many weeks the copper market has been living on "great expectations," and in spite of the fact that on numerous occasions the producers have displayed something amounting almost to genius in their inability successfully to manage their own affairs, speculators are lending support with eager hands. Their optimism was based on a report that a discussion will take place either in New York or London, to settle outstanding difficulties and to formulate a scheme whereby production will be cut down to a point which will permit of the dispersal of the unwieldy stocks now lying in the United States.

In the first place it must be remembered that production in America has already been cut to the bone, and yet so indifferent is the demand in face of a "pegged" price of 9 cents, that the primary producers have been forced to agree to a surrender of the market to the Custom plants during a four-month period. In spite of this, surplus American production is still crossing the Atlantic to this country, and one of the bones of contention at the conference will be whether or not this overseas dumping is to continue. As things stand the Americans may have might on their side but they hardly seem to have right, for while excluding, by means of a 4 cent duty, all foreign copper from their shores, they are continuing to compete on the European market. Canada, who formerly sent considerable quantities of her copper into the United States, has been badly hit by this tariff wall and is hardly likely to agree to any cut in her output so long as America continues to ship to Europe. As a matter of fact, it is unofficially understood that the Dominion does not intend to come into any curtailment scheme, and in view of her complex ores containing nickel and gold this is not remarkable.

What of Rhodesia? In somewhat guarded language the Rhodesian interests have expressed sympathy with a scheme for the betterment of the copper situation, but it is also quite obvious that they have no intention of taking another "bad deal," and from their point of view any plan for putting the red metal on its feet again must leave them ample scope for developing their great and valuable ore reserves. It is also common knowledge that Rhodesia does not favour a price *much* above the present level, and it seems evident that they foresee the most favourable developments for the industry along the lines of an ever-widening use of copper. In this they will have the support of all right-thinking people in the trade, for we saw quite enough of the evils of price manipulation during the *régime* of the late unlamented Copper Exporters, Incorporated.

Yet another awkward corner to be negotiated is the fact that the world's excess of copper supplies, both as to current output and stocks, is in the form of electrolytic, while the supply of fire-refined brands does hardly more than meet the demand. Practically all this class of copper comes from Rhodesia and Chile, and it has been suggested that in order to give their customers what they need these two countries should continue at their present rate and pay the electrolytic producers a subsidy to keep their copper out of the way. This sounds rather fantastic unless the price is to appreciate very considerably, and as already stated, Rhodesia is not thinking along the lines of a much higher quotation. Optimism is always good, but it should be tempered with caution, and in the case of copper the spirit of hopefulness seems to have been strained rather too far for safety.

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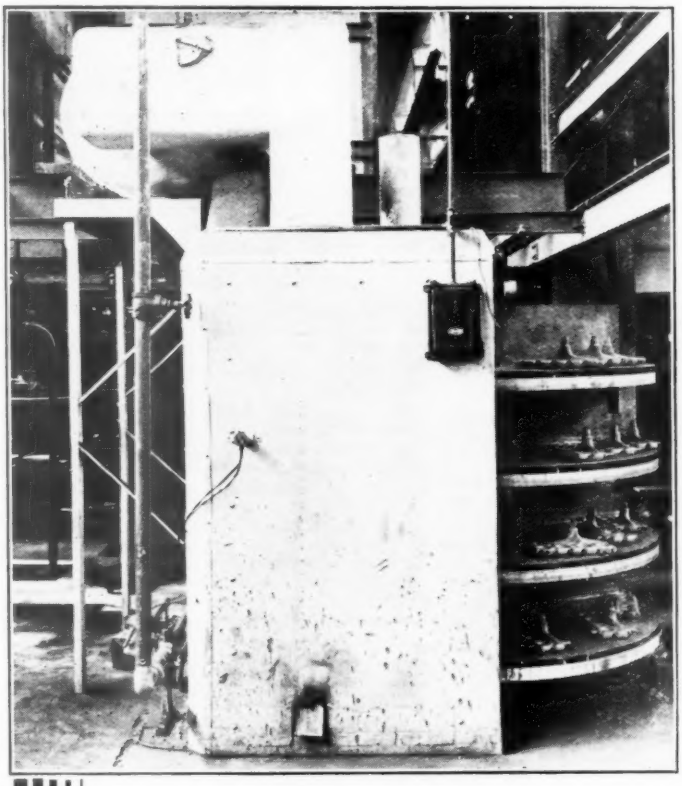

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Grain Size and Growth

EFFECT OF DEOXIDATION

In Co-operative Bulletin 65, published by the Mining and Metallurgical Advisory Boards, Carnegie Institute of Technology, C. H. HERTY, D. L. MCBRIDE and S. O. HOUGH discuss the "Effect of Deoxidation on Grain Size and Growth." The following is an extract of the authors' summary.

Summary

(1) The grain size of plain carbon steels is profoundly affected by the methods of deoxidation used.

(2) The rate of heating through the transformation range has a pronounced effect on the recrystallisation of silicon-killed plain carbon steels. Very little grain refinement occurs when heating rates faster than 5 deg. C. per min. are used, but below this rate grain refinement increases as the rate of heating decreases. Therefore, the larger the mass, the better the grain refinement for given heating conditions on these steels. Aluminium-killed steels show strongly-marked grain refinement regardless of the heating rate.

(3) Hydrogen-purified iron-carbon alloys, very low in impurities, show extreme localised grain growth at temperatures slightly above the Ac_1 point. In these alloys there is evidently no material present to act as an inhibitor of grain growth.

(4) In mild steels, 0.15 to 0.25 per cent. carbon, the finest-grained steels are those to which an excess of aluminium has been added for deoxidation. Semi-skilled steels to which a small amount of aluminium has been added are fairly fine grained in the normalised condition, and silicon-killed steels are more coarse grained than the semi-killed steels. Both semi-killed and silicon-killed steels are very coarse grained when heated to 1,000 deg. C. (1,832 deg. Fah.) for 1 hr. Steels with excess aluminium are still fine grained after this treatment, but become coarse grained at about 1,100 deg. C. (2,012 deg. Fah.).

(5) Silicon-killed medium-carbon steels are medium grained with considerable grain contrast in the normalised condition. As the silicon content is raised from 0.10 to 0.18 per cent., some decrease in grain size occurs with less grain contrast. The difference is presumably due to the fluxing action of FeO on the silicate particles in the lower silicon steels. There is probably a critical silicon content at which these steels should be rather fine grained. Above this the grain should coarsen because of the effect of the silicon in solid solution.

(6) Ladle additions of aluminium, amounting to 0.03 per cent., give a very fine-grained steel. If the aluminium is added in the furnace, either as a complex deoxidiser or as ferro-aluminium, the resultant grain size of the steel is very similar to that of a silicon-killed steel. It is evident that under these conditions the alumina particle has been fluxed, thus destroying its ability to act as a nucleus for crystallisation.

(7) Grain growth at 950 to 1,000 deg. C. (1,742 and 1,832 deg. Fah.) is essentially complete in about 20 min. at temperature for silicon-killed and aluminium-treated medium-carbon steels. At 950 deg. C., only the steel with a large excess of aluminium added was not coarse grained after heating for 90 min. at this temperature. At 1,000 deg. C., all the medium-carbon steels became coarse grained.

(8) Silicon-killed steels, in most instances, show a gradual grain growth with increasing temperature, but aluminium-treated steels suddenly change from fine grained to coarse grained within a very narrow temperature range. The temperatures at which marked grain growth commences increase with decreasing non-metallic particle size, as estimated from the method of deoxidation and data available on the fluxing action of the various oxides in the liquid steel.

(9) Grain size, on normalising at 925 deg. C. (1,697 deg. Fah.), parallels fairly closely the grain size found in the McQuaid-Ehn test.

(10) After overheating with resultant grain growth, complete grain-size recovery may be obtained by renormalising steels treated with an excess of aluminium during deoxidation. If 0.03 per cent. of aluminium is used, excellent grain-size recovery is observed, but this is not as consistent as with higher aluminium additions.

Electric Pot Furnace for Melting and Heat-Treating

A recent issue of "The Iron Age" contains the following particulars relating to a furnace built by the Hevi Duty Electric Company, Milwaukee, which is suitable for the heat-treatment of small parts and also for melting. The furnaces are supplied in both round and rectangular shapes. As indicated in Fig. 1, emphasis has been placed on insulation, which includes both high- and low-temperature slab material. Leaks to the furnace chamber are sealed off at the top of the pot by means of a sealing rope, and the top plate is of ribbed-alloy cast iron,

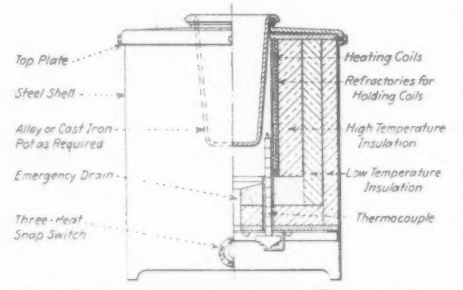

FIG. 1.—CONSTRUCTION OF THE RECTANGULAR HEVI-DUTY ELECTRIC-POT FURNACE.

likewise insulated to prevent heat loss. The effort has been to provide rugged construction and the outer shell is of steel plate. The heating elements are of the helical-coil type, made of heavy wire of nickel-chromium composition, and they are mounted on radiant refractories to reflect and radiate the heat to the furnace pot. Incidentally, the pots for melting are arranged for ready removal for ease in pouring.

A three-snap switch provides for three levels of temperature. For example, a furnace which takes 5,000 watts on the high input, developing a temperature of 870 deg. C. or more, takes 2,500 watts at the medium position, for a temperature of 595 deg. and 1,250 watts on low for a temperature of 400 deg.

IN HIS REVIEW of the industrial position at a recent meeting of the Glasgow Chamber of Commerce, Sir A. Steven Bilsland, the chairman, said that changes in the insured population in various industries and in the total number of persons employed had recently been analysed by the Ministry of Labour. The analysis, he said, was particularly interesting in the evidence which it supplied in denial of the common belief that machines are creating general unemployment. It showed that labour was migrating rapidly from the contracting to the expanding industries. For example, between 1923 and 1934 there was an exodus of 24,000 from the coal-mining industry, of whom 12,000 entered some branch of the building industry. The state of trade in the West of Scotland was fairly satisfactory. As far as steelmaking was concerned, prospects of a continuance of steady work were bright. There had been a considerable number of orders since the beginning of the year; four shipbuilding orders had been received on the Clyde during January, and Glasgow engineering firms and machinery makers had started the year with well-filled order-books.

Exchange Restrictions Abroad

PRESENT POSITION

A pamphlet dealing briefly with restrictions on foreign exchange transactions has been issued by the Department of Overseas Trade. In it is given an indication of the extent to which, if at all, prompt payment of current trade debts is, according to the Department's information, at present prevented by exchange control. The position in various countries is as follows :—

Europe

Denmark.—Import licences are required in respect of most classes of goods. No difficulties in obtaining sterling for the payment of *bona-fide* commercial transactions for which import licences are held by the importer.

Germany.—The Anglo-German Payments Agreement of November 1, 1934, provides that 55 per cent. of the value of German exports to the United Kingdom shall be earmarked for the payment for exports of United Kingdom goods to Germany. The percentage earmarked should, on the basis of the normal figures of imports and exports in recent years, enable sterling payments for United Kingdom goods to be made in full.

Italy.—The control has become stricter, but payment is forthcoming for *bona-fide* commercial transactions. Customs certificates are required in support of applications for foreign exchange.

Norway.—If the approval of the importer's bank has not been previously obtained, exchange may not be made readily available. Otherwise no difficulty has so far been experienced in obtaining payment.

Portugal.—The control over exchange transactions does not impede payment.

South America

Argentina.—A system of prior exchange permits is in operation, and exporters should satisfy themselves that the customers have obtained prior permits which will be used to cover the order before shipments are made. The permit authorises the importer to purchase exchange by tender at a rate appreciably better than the free market rate. Where importers have obtained prior permits for the importation of United Kingdom goods, no difficulty or undue delay in obtaining payments is to be anticipated.

Brazil.—The exchange position is difficult. Under the regulations at present in force, the supply of official exchange for United Kingdom goods is such that payment is likely to be made only after very long delays. Purchase of exchange in the free market is possible, but only at substantially greater cost to the importer. Representations have been made to the Brazilian Government with a view to securing a modification of the present regulations.

Chile.—There is no shortage of exchange, and permits to import against payment at the export bill rate (at present about 120 pesos = £1) are obtainable without difficulty for United Kingdom imports.

Uruguay.—There have been long delays in securing payment. A new system has been introduced under which imports are to be limited by means of import licences issued with regard to the amount of exchange likely to become available.

Other Countries

China.—The system of exchange control at present in force does not affect payments for *bona-fide* merchandise transactions.

Persia.—Importation of certain goods is reserved to the State, and all other goods are subject to quota restriction. Although there is no official exchange control, the position generally is far from satisfactory, and it is advisable that goods should not be shipped to Persia unless an advance payment has been received sufficient to cover the cost of reshipment and consequent loss should the importer be unable or refuse to take up the goods.

Portuguese East Africa.—Restrictions, amounting to prohibition, apply to many classes of goods. For other types payment is apparently secured.

Turkey.—There are extensive import restrictions and considerable delay in clearance is frequently experienced. There is understood to be no difficulty in obtaining exchange for ordinary business orders as and when goods are cleared through the Customs. Government and municipal orders require special sanction.

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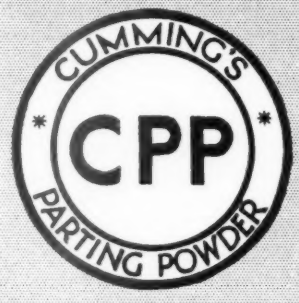

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This Week's News in Brief

Trade Talk

THE STAFF CLUB of Messrs. R. & A. Main, Gothic Iron Works, Falkirk, held their annual Burns Supper on January 25 under the chairmanship of Mr. C. McLean.

THE EMPLOYEES of Carron Company, Falkirk, have given the sum of £1,280 6s. 2d. to Falkirk Royal Infirmary and the sum of £679 4s. 5d. to other charitable institutions.

AN IMPORTANT FUSION in the wagon-building industry is taking place in Rumania, the Astra Company, of Arad, having acquired the entire capital, amounting to 100 million Lei, of the Unic Company, of Satu Mare.

ORDERS have been placed by Scottish Motor Traction Company, Limited, Edinburgh, with Messrs. F. D. Cowieson & Company, Limited, St. Rollox, Glasgow, for a number of all-steel bus bodies to the value of over £15,000.

AN ORDER has been secured by Messrs. Fleming & Ferguson, Limited, Paisley, for a powerful new dredger from the Nash Dredging Company, Limited, London. The vessel will be 165 ft. long with a breadth of 30 ft. and 11 ft. depth. Hull and engines will be built at the Paisley yard.

AT THE STAFF DINNER of the Brightside Foundry & Engineering Company, Limited, held in Sheffield recently, Mr. F. W. Firth (chairman of the company), who presided, spoke of the general revival of trade during the past 18 months, and said the company had not been slow to take advantage of it.

MESSRS. V. T. THOMPSON & ARNELL, London, have placed a contract for the building of a steamer for account of the Hall Bros. Steamship Company, Limited, Newcastle-upon-Tyne, with Messrs. Joseph L. Thompson & Sons, Limited, Sunderland. The vessel will have a capacity of 9,000 tons deadweight.

SPEAKING AT A DINNER in Dalmuir, Bailie Duff stated that Messrs. D. & J. Tullis, of Kilbowie Ironworks, were negotiating for an area of from three to four acres of ground adjoining their works, and it was calculated that from 150 to 200 extra hands would be employed when the extension was completed.

THE JOINT SECRETARIES of the Scottish Pig iron Trade Board have been informed by the accountants that the certified returns for October, November and December, 1934, made by the employers, show an average net selling price of £3 4s. 3d. This means that there will be no change in the wages of the workmen on basic rates.

GLASGOW CORPORATION WATER COMMITTEE have recommended acceptance of the offers of two firms for supply of cast-iron pipes, their tenders being the lowest. The successful contractors are: The Stanton Iron Works Company, Limited, 125 15-in. pipes, £582 16s. 3d., and 1,000 6-in. pipes, £1,237 10s.; and the Staveley Coal & Iron Company, Limited, 500 9-in. pipes, £1,227 1s. 8d.

THE KILMARNOCK ENGINEERING INDUSTRY has improved to a considerable extent during the last few months, and there are indications that the progress will continue. A feeling of much greater confidence appears to exist among prospective customers, and the export trade, even with countries where conditions for the past few years have been very unfavourable, is showing signs of revival.

A MEETING of the Wales, Monmouth and West of England Branch of the Institute of British Foundrymen was held at the Technical College, Newport, on Saturday, January 5, 1935, when Mr. E. J. K. Howard of Wimslow repeated his paper on "Bronze Castings." After an animated discussion, a vote of thanks was proposed by Mr. W. S. Kinsman, and seconded by Mr. A. J. Wall.

GRENOCK DOCKYARD COMPANY, LIMITED, launched the oil-tanker "Voreda," built to the order of Messrs. Gow, Harrison & Company, Limited, Glasgow. It is the last vessel to be launched from their existing shipyard, as under the scheme of exchange with Messrs. Scott's, Limited, they will shortly be transferring their activities to Messrs. Scott's East Yard. The machinery of the "Voreda" will be supplied by Messrs. John G. Kincaid & Company, Limited, Greenock, and is designed to give a speed of 12 knots in service. The vessel has a deadweight cargo capacity of 11,000 tons.

Personal

CAPTAIN H. J. KENNARD, R.N., retired managing director of Falkirk Iron Company, has resigned his position as Police Judge of Falkirk, and also his membership of Falkirk Town Council, owing to business demands.

AT THE ANNUAL STAFF DANCE of the Carron Company at Larbert, on January 26, a presentation of a gold watch was made to Mr. Peter Rae, J.P., who had completed 70 years of almost unbroken service. The presentation was made by Mr. F. L. Burder, chairman of the company.

MR. E. H. DOUGHTY, A.M.I.Mech.E., of British Timken, Limited, is to read a Paper, entitled "The Tapered Roller Bearing and Its Application to Rolling-Mill Equipment," before the Rolling Mill Committee of the Verein Deutscher Eisenhüttenleute at Düsseldorf on Tuesday, February 19.

MR. THOMAS WATSON, who joined the metallurgical department of Lukens Steel Company, Coalsville, Pa., U.S.A., in August, 1931, has been appointed development and service metallurgist. Mr. Watson is a native of Newarthill, and graduated from the Royal Technical College, Glasgow, in 1923, when he was assistant metallurgist at Messrs. D. Colville & Sons' works. Later he became metallurgist with the Clyde Alloy Company, Motherwell, and in 1927 went to Middlesbrough as assistant metallurgist to Dorman, Long & Company, emigrating to America in 1930.

MR. H. WINTERTON, Vice-President of the Institute of British Foundrymen, made his début as a magistrate at a sitting of the police court in Milngavie on January 21. He had a somewhat light schedule of cases to deal with, but his manner of administering the oath rather startled the court officials. He found the Scottish procedure was a little different from the English. It is customary, when a new magistrate appears, for the first offender coming before him to get off with an admonition. In Bailie Winterton's case it happened to be a gentleman charged with allowing his chimney to go on fire.

Wills

MARSHALL, C. C., of Northampton, ironworks manager	£42,561
LISTER, A. A., chairman of Messrs. R. A. Lister & Company, Limited, engineers, of Dursley	£100,724

Obituary

MR. FRANCIS J. BLIGHT, formerly chairman and managing director of Messrs. Charles Griffin & Company, Limited, the well-known firm of publishers, died on January 27, aged 77. Mr. Blight played an important part in the development, in this country, of the scientific text-book.

MR. CHARLES D. DOXFORD, director and general manager of Messrs. William Doxford & Sons, Limited, shipbuilders and engineers, of Sunderland, died on Monday, January 21, at the age of 79. He was the youngest son of Mr. William Doxford, who founded the firm in 1840, and had been actively connected with the company for 62 years.

MR. GEORGE BURT, director of the Acme Wringer Company, Limited, Bridgeton, Glasgow, died in a nursing home near Aberdeen on January 20, after a brief illness. Mr. Burt, who was 48 years of age, was the son of Mr. Peter Burt, of Bothwell. He was a prominent personality in Scottish cricket and represented his country on several occasions.

MR. DAVID REES BOWEN, Vice-President of the Farrel-Birmingham Engineering Company, has died in Connecticut, U.S.A. Aged 70, he received his early education at Llandovery, emigrating to the United States with his parents at the age of 17. He entered the employ of the Farrel Foundry & Machine Company as a machinist apprentice, and became a master of the technical requirements of many industries, designing and constructing machinery for use in a wide variety of processes.

WE WISH to thank the General Refractories Company, Limited, Genefrax House, Sheffield, for sending us a monthly tear-off wall calendar surmounted by pictures of new types of bricks.

Short Paper Competition

(*Concluded from page* 90.)

2 lbs. per sq. in. where the boxes are shallow, to about 4 lbs. where they are deep. If the casting is 2 ft. deep then 7 lbs. per sq. in. must be added to the above figures to obtain the pressure at the bottom of the mould. Every further foot of depth means an increase of 3½ lbs. per sq. in. No one would suggest that the same ramming, or the same permeability were required at the top and the bottom of the mould. A bench-test cannot meet the case, although it might help.

A Suggested Test

The apparatus envisaged would consist of a small air cylinder with pump and gauge attached. The cylinder should carry any pressure up to about 30 lbs., and attached to this cylinder is a flexible tube with a stop-cock. A joint plate with a fine cutter of 3 in. dia., ¼ in. deep, and the inside bored parallel, so that no extra compressing of sand takes place, is attached to lower end of tube. The joint plate might be faced with pliable rubber to assist in forming the joint when in use against the sand. When used, compress the air in the cylinder, by means of the hand-pump, to a pressure of double the actual pressure which the mould will have to withstand at the place of testing. Press the joint plate on the face of mould, at the selected point, turn on the pressure and note on gauge the time taken for the reading to fall from one point to another, selected as standard.

By this method the conditions of actual casting are reproduced much better than is possible during a bench or laboratory test, and the moulders' work can be shown to him. It ought to stimulate an interest in the work much better than a laboratory test on the sand only. It is not suggested that any testing apparatus at present in use is inefficient or useless, but rather that their use is essential for the *primary* testing of the sands. The apparatus described should be used in conjunction with them as a check against the mis-use by the moulder of any selected sand. It may be questioned why such a large area as 3 in. has been taken for test; but this would assist in getting away from the differences caused by the punch of the rammer. Of course, this could not be used on very small moulds, but could probably be introduced down ribs and bosses. The small damage to the moulds, made by the cutter, could be easily overcome by the moulder and metal dresser.

Forthcoming Events

The Institute of British Foundrymen

FEBRUARY 2.

Lancashire Branch:—Annual dinner.

Falkirk Section:—"Modern Sand Control in the Foundry." Paper by H. Cowan, B.Sc., at Lint Riggs, Falkirk, at 6 p.m.

FEBRUARY 6.

Preston Section:—"Some Impressions of Foundries in the United States of America." Paper by T. Makemson, at the Technical College, Corporation Street, Preston, at 7.30 p.m.

London Branch:—"Spraying of Cores and Castings." Paper by A. Roger, at the Charing Cross Hotel, London, W.C.2, at 8 p.m.

FEBRUARY 7.

Birmingham, Coventry and West Midlands Branch:—"Suggested Method of Establishing Melting Costs in a Grey-Iron Foundry." Results of investigations by Costing Sub-Committee, presented by H. J. Roe at the James Watt Memorial Institute, York House, Great Charles Street, Birmingham, at 7.30 p.m.

FEBRUARY 8.

Middlesbrough Branch:—"Ingot Moulds, Bottoms and Slag Ladles." Paper by J. Blakiston, A.I.Mech.E., at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

FEBRUARY 9.

Scottish Branch:—"Patternmaking." Paper by A. Marshall, at the Royal Technical College, George Street, Glasgow, at 4 p.m.

West Riding of Yorkshire Branch:—Visit to works of John Fowler (Leeds), Limited.

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AGENTS: GLASGOW - MANCHESTER - NEWCASTLE.

Raw Material Markets

Activity in the iron and steel industry is now returning to the pre-holiday level, and there are hopes of exceeding the production records established in October. There is a heavy demand for pig-iron in the home market, and export sales are also showing an upward tendency.

Pig-Iron

MIDDLESBROUGH.—With brighter prospects in certain leading branches of the foundry trade, notably shipbuilding and light castings, a decidedly optimistic view is taken of the outlook in the Cleveland iron trade. The current demand is heavy and still expanding, and the stocks accumulated at the furnaces during the recent short period of inactivity should soon be distributed. A number of substantial cargoes have recently been shipped abroad. There are still only three Cleveland blast furnaces producing foundry iron for the market, and the makers experience no difficulty in realising the agreed minimum prices. These are 67s. 6d. per ton for No. 3 Cleveland G.M.B. grade delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow, with the usual differences for other grades, viz., 2s. 6d. per ton extra for No. 1 foundry iron and 1s. per ton discount for No. 4 foundry and No. 4 forge.

The East Coast hematite trade is developing on very satisfactory lines. There is a heavy demand from home consumers, who are now ensuring supplies for the April/June quarter. Export trade is improving and there is a steady demand from Denmark and Italy. It is expected that an additional blast furnace will be lighted shortly at Consett. The minimum home quotations for No. 1 East-Coast hematite to home consumers are 69s. per ton delivered Middlesbrough and 71s. delivered North-East Coast, ranging up to 79s. delivered Birmingham.

LANCASHIRE.—Deliveries of pig-iron to foundries in the Lancashire area are maintained at a satisfactory level for this period of the year. Current business is not on a large scale, as the majority of users are already well covered. The price position in this section remains distinctly firm. Current offers of Staffordshire and Derbyshire brands of No. 3 foundry iron are all on the basis of 74s. per ton for delivery to Lancashire works, with Northamptonshire at 72s. 6d., Derbyshire forge at 69s., Scottish foundry at around 82s. 6d., West Coast hematite at around 78s. 6d. and East Coast at from 75s. to 76s., according to grade.

MIDLANDS.—More activity is reported at the jobbing foundries in this area, and the general engineers find business on the up-grade. Some of the larger repetition foundries are beginning to be busy again, and the demand for building castings should shortly rise to its usual spring peak. Altogether, the demand for iron is gradually moving upwards. The Midland brands of ordinary foundry iron are controlled, and the fixed prices delivered Birmingham and Black Country stations are 67s. 6d. per ton for Northants No. 3 and 71s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, these figures being subject to a small graduated rebate for large consumers. With regard to irons for general engineering work, just recently a Derbyshire iron, approximating to the analysis of Scottish iron, has been offered at the same price as ordinary Derbyshire No. 3, which may have the effect of bringing down some of the medium-phosphorus pig-iron prices. Up to now the figures have been anywhere between 72s. and 80s.; with 85s. to 87s. 6d. for the low-phosphorus varieties. Scottish No. 3 is still on offer at 85s. to 87s. 6d. per ton delivered South Staffordshire area. For special refined iron for engine and similar work there is a fair demand. Present quotations range from £5 7s. 6d. to £6 10s. per ton delivered, the prices depending upon the analysis and the tonnage involved.

SCOTLAND.—Business is still on the quiet side in the Glasgow pig-iron market. Scottish No. 3 continues to be quoted at 70s. per ton f.o.t. furnaces, with 2s. 6d. per ton extra for No. 1. Cleveland No. 3 remains at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow

Coke

There has been a rather better demand for foundry coke this month than there was during December, but, even so, business has been of a limited nature, so many consumers having previously entered into long-term contracts. Current quotations for delivery in the Birmingham area are as follow:—Best Durham, 36s. to 40s.; other grades, down to 34s.; Welsh, 35s. to 45s., according to analysis; Scottish low-ash coke, about 41s. per ton.

Steel

Rather quiet conditions have developed in most departments of the steel trade, states the official report of the London Iron and Steel Exchange. There is no loss of confidence in the markets, as in the majority of cases any decline in activity can be traced to seasonal influences upon the consuming trades. Conditions in the semi-finished steel department are not expected to become more active until consumers have worked off some of their contracts. As a result of the application of the British steelmakers for higher duties, few orders are going abroad. In the finished-steel department, activity is being maintained. Not only are specifications against existing contracts reaching the works on a satisfactory scale, but the volume of new business, which early in the New Year failed to reach expectations, is now showing signs of expansion. In spite of the difficulties in the way of export trade, the general tendency is for the demand from overseas steadily to improve.

Scrap

A very firm tone is noticeable in the Cleveland scrap-iron market. Foundrymen are now paying 55s. per ton for machinery quality and 53s. 6d. for ordinary heavy metal. In the Midlands, scrap-iron prices are very firm, and a rise may occur above the levels which have ruled for a long time. In South Wales there is a good demand for both heavy and light grades of cast-iron scrap, at 52s. and 42s. 6d. per ton respectively, but sales of good machinery scrap in foundry sizes are confined to a few odd truck loads at about 55s. per ton. Good-sized parcels of scrap are changing hands in Scotland at the current quotations, which are 55s. to 56s. for machinery grade and 52s. for ordinary cast-iron scrap, in pieces not exceeding 1 cwt.

Metals

Copper.—As far as this country is concerned, copper consumption is running on quite satisfactory lines, whilst conditions on the Continent are also reported to be improving. Nevertheless, the London copper market has displayed a somewhat uncertain tone, under the influence of "outside" factors, notably the fluctuating dollar exchange and the negotiations for an international copper conference. Apparently nothing has as yet come of the latter.

The reason for the uncertainty of the sterling-dollar exchange rate is the impending decision of the American Supreme Court on the "gold clause," which may have a very important bearing on the economic situation in the U.S. The decision is expected to be announced next Monday.

Daily quotations :—

Cash.—Thursday, £27 12s. 6d. to £27 13s. 9d.; Friday, £28 to £28 1s. 3d.; Monday, £27 17s. 6d. to £27 18s. 9d.; Tuesday, £27 10s. to £27 12s. 6d.; Wednesday, £27 5s. to £27 6s. 3d.

Three Months.—Thursday, £27 18s. 9d. to £28; Friday, £28 5s. to £28 6s. 3d.; Monday, £28 3s. 9d. to £28 5s.; Tuesday, £27 17s. 6d. to £27 18s. 9d.; Wednesday, £27 11s. 3d. to £27 12s. 6d.

Tin.—There has been little alteration in conditions in the tin market, a heavy backwardation continuing to exist between prices of spot and three months' metal.

"Trade demand in this country is fairly well maintained, and similar conditions prevail on the Continent; in the United States of America a moderate business was reported, but buyers are adopting a cautious attitude pending the removal of some of the uncertainties which still surround the general and economic position in that country. Broadly speaking, there is no material change in fundamental conditions, and a steady market seems likely to prevail pending some clearer indication as to how consumption will develop in the next weeks," report Messrs. Rudolf Wolff.

Market fluctuations :—

Cash.—Thursday, £232 10s. to £232 12s. 6d.; Friday, £232 to £232 5s.; Monday, £231 15s. to £232 5s.; Tuesday, £232 7s. 6d. to £232 10s.; Wednesday, £232 15s. to £233.

Three Months.—Thursday, £228 17s. 6d. to £229; Friday, £228 17s. 6d. to £229; Monday, £228 17s. 6d. to £229; Tuesday, £228 17s. 6d. to £229; Wednesday, £228 17s. 6d. to £229.

Spelter.—The result of the Import Duties Advisory Committee's inquiry into the existing 10 per cent. duty on foreign metal is being anxiously awaited. In the meantime, prices have firmed up slightly, there being quite a good demand from consumers in this country.

Official quotations :—

Ordinary.—Thursday, £11 18s. 9d.; Friday, £12 1s. 3d.; Monday, £12 3s. 9d.; Tuesday, £12 3s. 9d.; Wednesday, £12 2s. 6d.

Lead.—Interest in this market is centred on the inquiry into the import duty on foreign lead. Prices keep at a fairly steady level from day to day.

Day-to-day prices :—

Soft Foreign (Prompt).—Thursday, £10 8s. 9d.; Friday, £10 8s. 9d.; Monday, £10 7s. 6d.; Tuesday, £10 8s. 9d.; Wednesday, £10 8s. 9d.

Contracts Open

Edinburgh, February 12.—700 tons of cast-iron pipes of various sizes, for the Town Council. The Water Engineers, 29, Waterloo Place, Edinburgh.

Wallasey, February 12.—350 tons of cast-iron water main, for the Gas and Water Department. The Gas and Water Department, Gasworks, Wallasey.

South Africa, March 1.—12,439 cast-iron pipes, 3½ in. × 9 ft., for the Union Tender and Supplies Board. The Department of Overseas Trade. (Reference G.Y. 14,703.)

Godalming, February 4.—400 yds. of 4-in. water main, for the Town Council. Mr. E. G. Bowyer, water engineer, 35, Bridge Street, Godalming. (Fee £1 1s., returnable.)

Stafford, February 1.—60 tons of 4-in. and 3-in. dia. cast-iron pipes and specials, for the Town Council. Mr. W. Plant, borough and waterworks engineer, Borough Hall, Stafford.

Caistor, February 8.—60,000 yds. of cast-iron and spun-iron water pipes, up to 6-in. dia., with specials, etc., for the Rural District Council. Mr. J. H. Haiste, Middleton Chambers, Lowgate, Hull. (Fee £5, returnable.)

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RAW MATERIALS—PRICE LIST

(Wednesday, January 30, 1935)

COPPER

	£	s.	d.
Standard cash	27	5	0
Three months	27	11	3
Electrolytic	30	5	0
Tough	29	0	0
Best selected	29	10	0
Sheets	58	0	0
India	41	0	0
Wire bars	31	0	0
Ingot bars	31	0	0
H.C. wire rods	33	10	0
Off. av. cash, December	27	17	6 5/16
Do., 3 mths., December	28	5	4 1/16
Do., Sttlmnt., December	27	17	10 1/16
Do., Electro, December	31	6	4 11/16
Do., B.S., December	31	0	7½
Do., wire bars, December	31	11	0 13/16
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6d.

BRASS

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	8d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7⅛d.
Wire	7d.
Rolled metal	6⅝d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	232	15	0
Three months	228	17	6
English	233	0	0
Bars	235	0	0
Straits (nom.)	233	0	0
Australian (nom.)			—
Eastern	232	12	6
Banca (nom.)	236	0	0
Off. av. cash, December	228	5	1 1/10
Do., 3 mths., December	228	11	7 1/10
Do., Sttlmt., December	228	5	0

SPELTER

	£	s.	d.
Ordinary	12	2	6
Remelted	13	5	0
Hard	10	15	0
Electro 99.9	14	12	6
English	13	3	9
India	12	5	0
Zinc dust	17	0	0
Zinc ashes	3	0	0
Off. aver., December	11	17	5 3/16
Aver. spot, December	11	14	7 5/16

LEAD

	£	s.	d.
Soft foreign ppt.	10	8	9
Empire (nom.)	11	11	3
English	12	10	0
Off. average, December	10	8	1 1/10
Average spot, December	10	6	3 1/16

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	10	0
Do., V.M. ex-whse.	22	12	6
Rods	26	10	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	77	0	0	to	78	0	0
Chinese, ex-whse.					69	10	0
Crude						—	

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	2	6	to	11	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.		£	s.	d.
Ferro-silicon—							
25%					8	17	6
45/50%					13	0	0
75%					18	7	6
Ferro-vanadium—							
35/50					12/8 lb. Va.		
Ferro-molybdenum—							
70/75% carbon-free					4/6 lb. Mo.		
Ferro-titanium—							
23/25% carbon-free					9d. lb.		
Ferro-phosphorus, 20/25%					£14	10	0
Ferro-tungsten—							
80/85%					3/– lb.		
Tungsten metal powder—							
98/99%					3/3 lb.		
Ferro-chrome—							
2/4% car.					29	15	0
4/6% car.					23	0	0
6/8% car.					21	12	6
8/10% car.					21	12	6
Ferro-chrome—							
Max. 2% car.					34	0	0
Max. 1% car.					38	15	0
Max. 0.70% car.					42	0	0
70%, carbon-free					10d. lb.		
Nickel—99.5/100%					£200 to £205		
"F" nickel shot					£184	0	0
Ferro-cobalt, 98/99%					5/3 lb.		
Metallic chromium—							
96/98%					2/5 lb.		
Ferro-manganese (net)—							
76/80% loose	£10	15	0	to	£11	5	0
76/80% packed	£11	15	0	to	£12	5	0
76/80% export	(nom.)				£9	15	0
Metallic manganese—							
94/96% carbon-free					1/2 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/8 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel					2	16	0
Bundled shrngs.					2	7	6
Mixed iron and steel	2	10	0	to	2	12	6
Heavy cast iron					2	12	0
Good machinery					2	15	0
Cleveland—							
Heavy steel					2	12	0
Steel turnings					1	15	0
Cast-iron borings					1	5	0
Heavy cast iron					2	13	6
Heavy machinery					2	15	0
Midlands—							
Light cast-iron scrap					2	7	6
Heavy wrought iron					3	0	0
Steel turnings, f.o.r.					1	14	0
Scotland—							
Heavy steel					2	10	0
Ordinary cast iron	2	11	6	to	2	12	6
Engineers' turnings					2	0	0
Cast-iron borings	1	17	6	to	1	18	6
Wrought-iron piling					2	12	6
Heavy machinery	2	15	0	to	2	16	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	25	0	0
Brass	16	10	0
Lead (less usual draft)	9	10	0
Tea lead	6	10	0
Zinc	8	0	0
New aluminium cuttings	66	0	0
Braziery copper	20	0	0
Gunmetal	23	0	0
Hollow pewter	160	0	0
Shaped black pewter	118	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/–
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/–
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/–
,, No. 3 fdry.	71/–
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/–
,, fdry. No. 3	71/–
,, fdry. No. 1	74/–
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/–
Hem. M/Nos. d/d	71/–
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/–
Staffs fdry. No. 3	74/–
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	10	0	to	8	0	0
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	and up.			
Bolts and nuts, ¾ in. × 4 in.	14	0	0	and up.			
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	9	7	6
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅝ in. (Untested)					8	12	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)					9	7	0
Black sheets, 24g. (4-t. lots)					10	10	0
Galv. cor. shts. (,,)					13	0	0
Galv. flat shts. (,,)					13	10	0
Galv. fencing wire, 8g. plain					14	10	0
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	0	0	to	5	7	6
Tin bars	5	2	6	to	5	7	6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11d.
Rods	10d.
Tubes	13d.
Castings	10⅝d.

Delivery 3 cwt. free.

10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.

C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/– to 30/–
,, furnace	19/– to 20/–
Durham foundry	20/– to 25/–
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/2 to 18/6
,,	28×20	,,	36/4 to 37/–
,,	20×10	,,	26/– to 26/3
,,	18¾×14	,,	18/6 to 18/9
C.W.	20×14	,,	15/6 to 16/6
,,	28×20	,,	33/– to 33/6
,,	20×10	,,	23/– to 24/–
,,	18¾×14	,,	16/– to 17/–

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.

[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.	
Jan. 24 ..	27	12	6	dec. 8/9
,, 25 ..	28	0	0	inc. 7/6
,, 28 ..	27	17	6	dec. 2/6
,, 29 ..	27	10	0	,, 7/6
,, 30 ..	27	5	0	,, 5/-

Electrolytic Copper

	£	s.	d.	
Jan. 24 ..	30	15	0	dec. 5/-
,, 25 ..	31	0	0	inc. 5/-
,, 28 ..	31	0	0	No change
,, 29 ..	30	15	0	dec. 5/-
,, 30 ..	30	5	0	,, 10/-

Standard Tin (cash)

	£	s.	d.	
Jan. 24 ..	232	10	0	inc. 2/6
,, 25 ..	232	0	0	dec. 10/-
,, 28 ..	231	15	0	,, 5/-
,, 29 ..	232	7	6	inc. 12/6
,, 30 ..	232	15	0	,, 7/6

Tin (English ingots)

	£	s.	d.	
Jan. 24 ..	232	12	6	No change
,, 25 ..	232	7	6	dec. 5/-
,, 28 ..	232	2	6	,, 5/-
,, 29 ..	232	12	6	inc. 10/-
,, 30 ..	233	0	0	,, 7/6

Spelter (ordinary)

	£	s.	d.	
Jan. 24 ..	11	18	9	No change
,, 25 ..	12	1	3	inc. 2/6
,, 28 ..	12	3	9	,, 2/6
,, 29 ..	12	3	9	No change
,, 30 ..	12	2	6	dec. 1/3

Spelter (Electro, 9.99 per cent.)

	£	s.	d.	
Jan. 24 ..	14	10	0	dec. 1/3
,, 25 ..	14	12	6	inc. 2/6
,, 28 ..	14	13	9	,, 1/3
,, 29 ..	14	12	6	dec. 1/3
,, 30 ..	14	12	6	No change

Zinc Sheets (English)

	£	s.	d.	
Jan. 24 ..	23	10	0	No change
,, 25 ..	23	10	0	,, ,,
,, 28 ..	23	10	0	,, ,,
,, 29 ..	23	10	0	,, ,,
,, 30 ..	23	10	0	,, ,,

Lead (English)

	£	s.	d.	
Jan. 24 ..	12	10	0	No change
,, 25 ..	12	10	0	,,
,, 28 ..	12	10	0	,,
,, 29 ..	12	10	0	,,
,, 30 ..	12	10	0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL RAILS

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	16 10 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1931	8 9 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 8
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1934	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 9	70 0	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 11½
1930	78 2½	78 0	76 9	75 0	74 0	72 7½	71 0	71 0	71 0	71 0	70 10½	70 4½	73 3½
1931	70 0	69 0	68 0	66 8½	65 1½	63 4½	62 9	61 1½	65 0	65 0	65 0	65 0	65 6
1932	64 10	64 3	63 6	63 6	63 6	62 7½	62 0	60 6	60 0	59 3	59 0	59 0	61 10
1933	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 3	60 7½	62 6	62 6	59 8½
1934*	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	68 0	68 6	68 6	68 6	67 2

* Since March, 1934, delivered works; previously f.o.t. furnaces.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

ADVERTISER seeks position with progressive firm as Foundry Works Manager or Superintendent with sole charge of pattern-shop; 10 years superintendent with American corporation; first-class references.—Box 128, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager, qualified Metallurgist (young), desires change; experienced production alloy cast iron and steel, brass and bronze castings for marine Diesel and motor-car engines, general engineering and electrical trades; sound knowledge up-to-date production methods; accustomed control electric arc, air and cupola furnaces; able to introduce business.—Box 120, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

METALLURGIST (Malleable or Grey-iron Foundry) requires position; expert in refining irons to special analysis; would act as chief chemist and take charge of melting, heat-treatments, and assist manager.—Box 130, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WORKS Manager and fully-qualified Chemist, with many years' management experience in manufacture and application of all classes of vitreous enamels, specialised in acid-proof enamels, requires change of appointment. Suitable post abroad not refused.—Box 114, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager required; must have had experience in mechanised methods for production of repetition flat work and baths; only men of first-class qualifications and excellent disciplinarians need apply.—Full particulars to Box 132, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOR SALE BY PRIVATE TREATY

By Order of Triplex Foundry, Limited, of Great Bridge, Staffs (makers of Patent Triplex Grates), who have removed to their new works in the same area

FOR SALE BY PRIVATE TREATY.
GREAT BRIDGE, TIPTON, STAFFS
(about 7½ miles from Birmingham and 5½ from Wolverhampton),
IN THE HEART OF THE BLACK COUNTRY INDUSTRIAL AREA.

FREEHOLD WORKS PROPERTY (mainly Ground Floor), situate
TOLL END ROAD AND BRIDGE ROAD, GREAT BRIDGE, TIPTON,
having a
TOTAL AREA OF 17,900 SQUARE YARDS,
or thereabouts, with
EXCELLENT ROAD AND CANAL FRONTAGES,
and comprising
MANUFACTURING PREMISES,

With an EXCELLENT BLOCK OF MODERN OFFICES; a Capital FOUNDRY with first-class Melting Plant; a Smaller MANUFACTORY or GARAGE and DWELLING-HOUSES. Would divide if necessary.

Viewing any time by appointment.

Vacant possession of the Works Premises upon completion.

Printed Particulars with Plans may be obtained from J. V. BOSWELL & COMPANY, F.A.I., 4, Waterloo Road, Wolverhampton, or CHESSHIRE, GIBSON & COMPANY, F.A.I., 21, Waterloo Street, Birmingham 2.

PROPERTY

TO LET.

FOUNDRY with railway and canal sidings close to Leicester. Rental £150 p.a. Area of foundry and store-yard 4,887 sq. yds. Abundance of local labour. Premises are suitable for any of the heavy trades. Excellent office accommodation, area 273 sq. yds.—Apply in first instance to F. W. CLARKE & COMPANY, Incorporated Accountants, 24/28, Corridor Chambers, Market Place, Leicester.

MACHINERY

FOR Sale, surplus to requirements, two E.R.3 type Universal Roll-over Moulding Machines. Hydraulic Squeeze, in new condition: pressure 10 tons at 750 lbs. per sq. in., available height between table and ramming plate 2 ft. 0⅜ in., stroke of ramming piston 11⅛ in., stroke of drawing piston 4 in. Will take boxes up to 31½ in. long x 21¼ in. wide. What offers?—WILLEY & COMPANY, LIMITED, Engineers, Exeter.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Fridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

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